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Brooklyn-Battery Tunnel, New York

No. I

THE Brooklyn-Battery tunnel, the fourth and the newest of New York's subaqueous vehicular highways, was opened to traffic on May 25th, 1950. Its entire length between its terminal plazas in Brooklyn and Manhattan is close to 11,000ft—approximately 2·1 miles, and about ¼ mile longer than the corresponding length of the Holland tunnel, under the Hudson River, and ¼ mile greater in length than the Queens-Midtown tunnel, which underruns the East River, 4¾ miles to the northward.

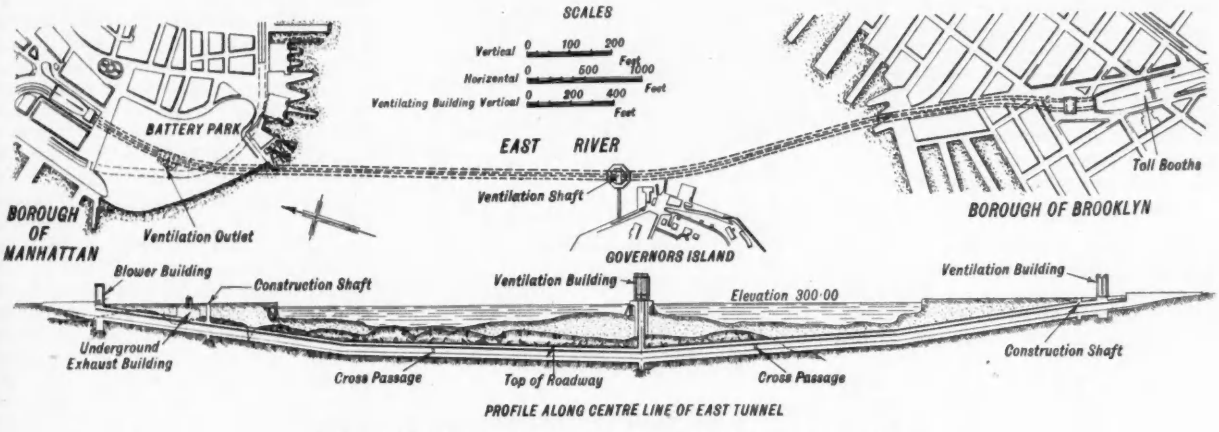
The present tunnel is lined with cast iron rings 31ft in outside diameter, as was the Queens–Midtown tunnel, and each ring is composed of fourteen segments and a relatively small key number. Two of the fourteen segments are flared inwardly at their opposed sides to form a keyway for the insertion of the key unit. Each ring has a longitudinal dimension of 32in, as was likewise the case for the Queens-Midtown tunnel, where the longer rings had the merit of reducing the amount of caulking to be done on the job, and the total number of bolts and a weight of 20 tons.

The Brooklyn-Battery tunnel was presented in the form of a preliminary plan by the chief engineer of the Department of Plant and Structures as far back as January of 1929, but it was not until seven years later that the Board of Transportation of New York City reported that the proposed tunnel "would be one of the most useful of public improvements." The New York State Legislature in January of that year had called into being the New York City Tunnel Authority and authorised it "to construct and operate the Brooklyn-Battery tunnel as a self-liquidating and self-supporting project." But money for that purpose was not obtainable until June 28, 1940, when the Reconstruction Finance Corporation—a Government organisation created during the depression—made available a loan of 57,000,000 dollars. Thus, more than four years elapsed between the granting of authority to construct and the beginning of work.

After sinking construction shafts for which ground was broken in October, 1940, actual tunnel driving began in the latter part of February, 1942, at the Brooklyn end of the project—work on this tunnel contract having been started in the latter part of June, 1941. Similar work started at the Manhattan end near the close of October, 1941, actual tunnel driving being started in January, 1942. Good progress was made at the oppositely advancing headings during 1942; but all work on the undertaking was suspended by the Government in January of 1943, owing to wartime restrictions. Permission to resume construction activities was not granted until well nigh three years later. During the years of halted work, the costs both of labour and material increased from time to time.

The Brooklyn-Battery tunnel furnishes an express highway crossing of the East River and the associate Buttermilk Channel, connecting the Battery on Manhattan and Brooklyn at its southern and populous area, and provides a superior outlet for vehicular traffic from that section of Brooklyn and adjacent Bay Ridge and Flatbush intent upon reaching Manhattan, and is intended to revive and stimulate commerce and industry in Brooklyn. It also serves as a necessary link in the express highway and parkway systems of both Long Island and Manhattan.

Between portals, the tunnel has a length of 9117ft, and the course of the twin tubes from the Manhattan construction shaft to the Governors Island ventilation shaft is generally straight and then swings slightly eastward to the Brooklyn shore at the foot of Hamilton Avenue, and thence, with a slight curve westward, to the portal located inland 1800ft from the bulkhead line. The minimum radius of curvature is 1562·5ft for a short length of curve near the Brooklyn portal, and most of the curves have radii of 2400ft or more. The general direction of the alignment is north and south. In Manhattan, the tunnel curves under Battery Park to tangents parallel with the lines of Washington and Greenwich streets, just north of Battery Park, where an area formerly occupied by numerous old and dingy brick structures has been razed to accommodate the nothern plaza and its entrance and exit portals. In addition to the mid-river ventilation shaft near the north-easterly shore of Governors Island, the tunnel is further ventilated from buildings located in Brooklyn and Manhattan, adjacent to the portals. The mid-river shaft does not in any way interfere with shipping moving up and down the East River; it was needed because of the long distance between the terminal ventilation structures. The maximum upgrade in the tunnel between portals is 3·7 per cent in one tube and the maximum downgrade is 4 per cent in the other tube, with the gradient gradually diminishing to 0·7 per cent near the centre of the river.



GENERAL PLAN AND PROFILE OF BROOKLYN-BATTERY TUNNEL

used, and lessened the number of shield shoves on the entire job, which was completed in a little more than four years. The segments that make up a heavy cast iron tunnel ring require four high-strength-steel, cross-flange bolts, while that forming the so-called light cast iron lining have five cross-flange bolts—the fifth being added to improve watertightness in the more flexible light-weight linings. The contiguous rings are tied together by eighty-five high-strength steel bolts in the adjoining circumferential flanges. A light ring, used in rock, has 11in flanges and weighs about 12·5 tons, while in soft ground and at mixed faces the heavy ring is used which has 14in flanges and weighs approximately 22·7 tons. The bolts for the heavy rings are 1⅜in diameter, and those for the light rings are 1⅛in in diameter. Taper rings have circumferential flanges cast and machined from zero to 1½in or 2½in less than the normal 32in apart, at opposite circumferential points, and such rings are used to produce a vertical or horizontal departure from normal either to cause a deflection of the line of a tunnel or to make corrections in the alignment or grade wherever indicated. Such rings also have a maximum length of 32in. As a matter of comparison, the rings of the Holland tunnel are 29ft 6in in diameter, and each has a length of 30in

Borings made along the projected tunnel line before the war were of importance because they disclosed for the first time accurately the contour of the subaqueous rock surface both underlying Battery Park and beneath the East River and the Buttermilk Channel. It was discovered that the rock line beneath the Battery and Governors Island was higher than previously assumed, and, therefore, that would make it possible to lower the tunnel profile below the line previously planned. In that way, it would be practicable to drive a much greater length of the tunnel in rock and have a minimum cover of about 10ft of rock. Incidentally, it would obviate a corresponding measure of tunnelling work under compressed air. There was only one difficulty to be mastered, and that was near the shore line and under Battery Park, where the borings indicated an abrupt dip or valley in the rock line, crossing both of the projected tubes and extending down to the roadway level of one tube and some feet below the invert of the other tube. Throughout that section, the tunnel would have to be driven under compressed air

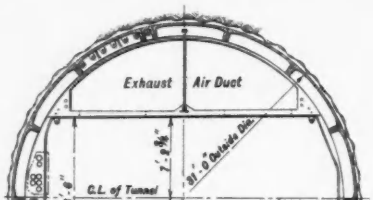
operation. From that point southward, the tunnel would have adequate rock cover, thence under the East River and southward for about 1000ft beyond Governors Island, where the ledge on which Governors Island stands dips below the bottom of Buttermilk Channel, the bed of which consists of stratified silt and clay. From the Brooklyn bulkhead line southward to the portal on Hamilton Avenue in that borough, the ground is a formation of stratified sand and gravel with some clay and boulders. The maximum depth of the tunnel roadway would be 115ft below mean high water at the point where it intercepted the ventilation shaft close to the north-east shore of Governors Island. That depth is 20ft deeper than the maximum underwater elevation of the Queens–Midtown tunnel roadways. The geological conditions broadly indicated rock tunnelling for about two-thirds of the projected tunnel length between construction shafts, and soft-ground and mixed-face driving for the remaining one-third.

During the preparatory stages of the planning of the Brooklyn-Battery tunnel the intention of the New York City Tunnel Authority was to divide the work between the construction shafts in Brooklyn and Manhattan into three major contracts, designated as Contracts 5, 6 and 7, respectively. Contract 5 was to extend northward from the two construction shafts in Brooklyn to the waterfront at Hamilton Avenue and thence out under the Buttermilk Channel to a point about 3200ft from the Brooklyn shafts, where the two headings would penetrate the ledge to full rock cover when nearing Governors Island. Contract 6, starting at the single construction shaft to be sunk in Battery Park, was to extend southward for a distance of 2800ft, while Contract 7—long delayed in its awarding—was to include the ventilation shaft in mid-river and rock tunnelling in the Governors Island ledge for a combined distance north and south from the shaft of about 1750ft. Circumstances changed this plan somewhat. When Contracts 5 and 6 were being energetically carried out and Contract 7 still remained unawarded, the intervening rock tunnelling was divided, north and south from the Governors Island shaft to the two concerns engaged under Contracts 5 and 6. This was a logical course because they had the necessary facilities and working forces available.

To George H. Flinn Corporation was awarded Contract 5, and on June 23, 1941, that contractor started work. The starting point in Brooklyn was at two construction shafts previously sunk by Andrew Catapano. The sinking of those shafts had been fraught with difficulties because of the high level of ground water at that point on Hamilton Avenue, approximately 1400ft inshore from the U.S. bulkhead line. The ground water there was about 10ft below the street surface at mean high tide. In excavating for the two shafts—each of which is placed directly over one of the two tubes, the contractor made use of three dewatering wells, capable of receiving 500, 600 and 1000 gallons of water a minute, and as a further means of controlling the water, he had recourse to well points. The water in those wells was returned to the ground by pumping to three diffusion pits about ½ mile distant from the construction shafts.

The diffusion wells were required as a water conservation measure, but the same ground water presented a problem to the tunnel driver when he began his construction operations. The tops of the tunnel tubes were but 10ft below the ground surface and only a few feet above the normal ground-water level. From the construction shafts the tunnel axis descends toward the East River on a gradient of about 3·7 per cent, and a limited cover over the tubes and the presence of the water made it risky for the contractor to begin his work under compressed air without inviting a blow-out if the air pressure should cause an unbalanced head. That hazard was likely to continue until the shield had moved forward and downgrade for several hundred feet northward from the shaft. The most promising method of meeting the situation was to unwater the ground and so permit the shields to advance under normal air until they reached the depth which would be ample to safeguard against a blow-out should air pressure then be adopted. The tunnel contract provided that the dewatering wells and diffusion system used in shaft sinking be turned over to the tunnel driving contractor, and, in addition to those wells, the Flinn Corporation had recourse to a Ranney dewatering installation, which proved eminently satisfactory.

That plant consisted of a dewatering shaft 11ft inside diameter, with concrete walls 1ft 2in thick, that was sunk to a depth of about 63ft below the level of mean high water, and from that shaft radiated twelve



CROSS SECTION OF WEST TUNNEL IN EARTH

CROSS SECTION OF BROOKLYN-BATTERY TUNNEL

horizontal strainer pipes spaced uniformly around the circumference of the shaft. Those pipes were located at an elevation of around 57ft below mean high water. The shaft was sunk between the tunnel tubes and 300ft north of the construction shafts. The longest strainer pipe extended 180ft southward of the dewatering shaft and along the general line of the tunnel tubes. In this manner, the area broadly traversed by the tunnel tubes was covered by the radiating strainer pipes, which had an aggregate total length of 1083ft from the dewatering shaft. From this concentration point to 120ft northward of the dewatering well—more than 400ft north of the construction shafts, the elevation of the drainage system was 10ft below subgrade of the tunnel tubes.

Each strainer was made up of an outer and an inner steel pipe, and the outer pipe had an external diameter of 8⅝in, with ⅜in walls in which were slots ⅝in wide and 1½in long, spaced on 2⅝in centres longitudinally, and 1in centres circumferentially. A cast steel driving head was placed on the end of the outer pipes, and the pipes were jacked out of the shaft, in 8ft lengths, through openings in the shaft walls. As each length was jacked outward, the inner strainer pipe, 7in in outside diameter, with $\frac{1}{16}$in walls, was placed inside the outer sections. The inner pipes are slotted with openings 1½in long and $^{3}/_{32}$in wide, spaced 2in on centres longitudinally and ½in on centre circumferentially. The successive 8ft lengths of outer pipe were welded together as the piping was jacked out of the shaft, while 8ft sections of the inner pipes were merely butted together. Rubber gaskets, equally spaced around the inner pipe, separated it from the outer pipe and prevented lontigudinal flow in the annular space between inner and outer pipes. Steel lugs on the inner pipes were also provided as spacers. During jacking, the driving head was connected to a 2in line extending into the shaft to drain sand and water. This 2in line could also be used for jetting. A steel and rubber plug was kept in position at the shaft wall in the inner pipe to prevent flow except through the 2in sand line. When in their final position, the inlets at the shaft of the strainer pipes were equipped with valves.

The dewatering shaft was equipped with two pumps, each of 2200 g.p.m., that started operation on December 19, 1941, and lowered the ground-water elevation as much as 29ft in the course of twenty-four hours. Continued pumping at the shaft and also at the three wells at the construction shafts at the rate of 4200 g.p.m. lowered the ground water to an elevation below the subgrade of the tunnel tubes as far as 450ft north of the construction shafts, and as long as desired that level was maintained. Besides solving the problem of a possible unbalanced head and the use of compressed air, the successful lowering of the ground water permitted the contractor to start his tunnelling operation in free air, thus avoiding the slower and costly work that would have been needed when using the air decks of the construction shaft.

Material for the two tunnel shields reached the construction shafts in the first half of December, 1941, and shield progress in free air began at the east tube before the end of the succeeding February, and at the west tube similar work got under way on March 11, 1942. The shields were substantially similar to those used in driving the twin tubes of the Queens–Midtown tunnel. As has been reported: "With some display of optimism the contractor made provision for installing mud locks and bulkheads in those shields, expecting to be able to shove the shields partially 'blind' through the material indicated to be stratified silt and clay under Buttermilk Channel." He was not able to do so during actual operation. In fact instead of advancing while admitting into the shield a relatively small quantity of the river bottom displaced at each shove, it was found necessary to excavate all of the displaced material. All that material had to be passed rearward to and through the material locks and moved thence to the construction shafts, whence it was hoisted to the surface for final disposal.

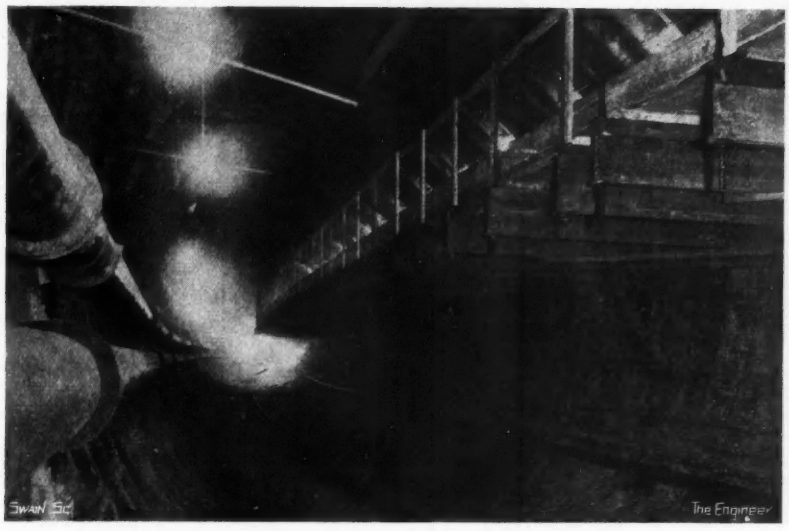
From the Brooklyn shafts the shields were separately advanced under free air to a point where they reached a depth of 46ft below mean high water—the work of excavating and erecting the heavy lining rings proceeding the while. Then, in each tube, and approximately 150ft rearward from the tunnel lining, the contractor constructed a concrete bulkhead with the conventional lock and other features, and with that done, tunnelling continued for three months under low air pressure—the dewatering installation running the while. By the time when work was stopped by the Government, the east tube had been advanced 1215ft northward from its construction shaft, and the western tube had reached a point 636ft from its shaft. The contractor then built in front of each

shield a concrete bulkhead, and at that time the use of compressed air within the twin tubes ceased. The shields and other equipment were left standing in the tunnel sections and kept dry by pumping. During the succeeding period of suspension of work, the apparatus was thus safeguarded from deterioration and generally maintained ready for service until the War Production Board authorised resumption of operations in November of 1945.

The shields that have been used by the Flinn Corporation weigh 400 tons each, fully equipped, have an outside diameter of 31ft 8in, and an internal diameter at the tail of 31ft 2in, thus providing a clearance of 1in all round between tube lining and the tail of the shield. Within the tail section are mounted in a vertical circle twenty-eight hydraulic jacks of 10in diameter designed to operate generally at a unit pressure of 5000 lb per square inch. Numerous other hydraulic jacks are also carried to operate sliding platforms at the face of the shield and to carry a waler beam for bracing the face of the heading when the ground had to be held. Each shield has an overall length of 15ft 10in. While advancing through the soft ground under Hamilton Avenue, in Brooklyn, pea gravel and grout were blown out through the ground. The grouting served to stabilise the enveloping ground and to minimise settlement. This was necessary because of the buildings on each side of the avenue. While driving was done in free air, the Flinn Corporation was able to erect three rings of heavy lining in each tube in twenty-four hours, and about the same progress was achieved in the earlier stages when operating under compressed air.

When the war halted operations in Brooklyn, the more advanced heading was less than 200ft from the river front. After resumption of work in November, 1945, both shields forged steadily onward, but progress at both headings slowed down considerably while working through the stratified silt and clay of the Buttermilk Channel's bed, and the twenty-four-hour advance ranged between 7ft and 8ft. When the leading shield was just 1000ft from Governors Island it began to enter Manhattan schist of the ledge from which that island rises. From that point onward for approximately 400ft, the tunnel drivers had to forge ahead against a mixed face, with the rock sloping upward until the heading was within rock cover. That is usually slow and laborious work. Once entirely in the rock better headway was possible, and further progress was made by recourse to the bottom-heading method. When entering the mixed ground, however, continuous breasting work was necessary.

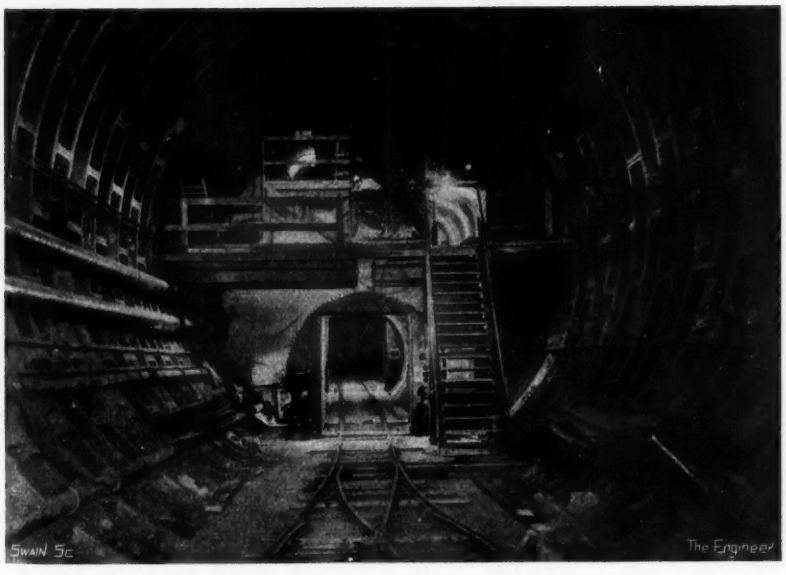
At several points under the Buttermilk Channel, where the natural cover of the water bed is not of sufficient thickness to overbalance the air pressures in use within the shields, it was necessary to provide a suitable "blanket" of clay. In mid-stream, for instance, where the natural cover has a thickness of only 12ft, a 22ft blanket of clay was deposited throughout that area of the channel bottom, and removed as quickly as practicable afterwards to restore the much-used channel to its prescribed navigable depth. At the greatest working depth reached by the shield, the sandhogs worked under an air pressure of 37 lb per square inch, and wherever the air pressure exceeded 25 lb per square inch two air locks were installed approximately 800ft apart with a differential pressure intervening. The men walked throughout that interval, thus helping in decompressing themselves several pounds the while, and then their decompression was completed within the second lock. Within the rock section in the vicinity and beneath Governors Island, the tunnel lining is of the light type, and weighs 12·5 tons a ring. The two shields were brought to a standstill by the contractor about 1000ft short of the point where holing through was to take place. and 20ft by 20ft drifts were advanced to within about 15ft of the face of the Manhattan tunnels, later to be enlarged to full section without the use of the shields.



EAST TUNNEL SHOWING HIGH LINE, CONTRACT 5

Much of the work done by the George H. Flinn Corporation required large volumes of low-pressure air for shield operation, and a lesser volume of high-pressure air to drive rock drills, clay diggers, and other pneumatic apparatus. The power plant in Brooklyn was equipped with five low-pressure compressors having a combined capacity of 29,300 cubic feet per minute, and the high-pressure units were two in number, each with a capacity of 2030 cubic feet per minute. Three pumps furnished the necessary pressure for operating the hydraulic jacks on the two shields at a maximum pressure of 6000 lb per square inch. There were in service other pumps for drainage and dewatering, and in each tube there was installed a 6in blow line from the heading rearward to the shaft bulkhead, where the water was discharged and there picked up by pumps that lifted it to the surface for discharge into a nearby sewer.

(To be continued)



CONCRETE BULKHEAD IN WEST TUNNEL, CONTRACT 5

NUFFIELD FOUNDATION DOMINION TRAVELLING FELLOWSHIPS.—The Nuffield Foundation is extending the Dominion Travelling Fellowships scheme—already in operation for Australia, Canada, South Africa and New Zealand—to the new dominions of Ceylon, India and Pakistan. The object of the travelling fellowships is to advance the interests of the new Dominions and to strengthen further their academic ties with the United Kingdom. The operation of the fellowships will enable men and women graduates of outstanding ability and with some post-graduate experience from those Dominions to gain further experience and training in the United Kingdom in their chosen fields of study, and to make contact with scholars working here in those fields, so that the fellows may equip themselves to take up senior posts in teaching and research on return to their own Dominions.

European Machine Tool Trade

By L. A. FERNEY

IN September, 1949, there appeared under the imprint of the O.E.E.C., Paris, a bilingual booklet entitled "Machine Tools" (Machines-Outils).*

It is the first official attempt to give an overall picture of Europe's machine tool production and trade. Its several imperfections notwithstanding, it gives an excellent and clear graphical presentation of comprehensive statistical information.

The avowed object of the publishing authority was to show in this report that there were some important gaps and shortcomings in the European manufacturing and importing programmes in this key branch of mechanised industry and industrial economy in and for formulating individual future policies to their, and their country's, best advantage.

Range of the O.E.E.C. Report

The following participated in the present enquiry: Austria, Norway, Belgium-Luxembourg, Portugal, Netherlands, Sweden, Denmark, Switzerland, France, Trieste, Greece, Turkey, Iceland, United Kingdom, Ireland, Bizone of Germany, Italy, French Zone of Germany. In what follows they will be referred to as "participating countries."

Some of them do not manufacture machine tools, and import but few, but all large European producers with the notable exception of Czecho-Slovakia, the Russian Zone of Germany, and the U.S.S.R., are included.

The participating countries were asked to supply data on their production, imports and exports of six main categories of machine tools; imports from and exports to participating and to non-participating countries, to be shown separately.

The six main categories of machine tools were sub-divided into a total of thirty-three sub-categories, as follows:—

Main Category	No. of Sub-categories
Automatic lathes	5
Gear-cutting machines	5
Grinding machines	13
Boring and milling machines	5
Centre lathes	3
Planing machines	2

The report states that these categories represent but one-third of the machine tool market. The author, however, believes that they represent a much larger fraction, so that the report covers an adequate cross-section of the trade.

Each country's production is given both in tonnes and in 1948 dollar values. These figures are given for three years, 1938, 1947 and 1952/3. The choice of these three years does not seem to be particularly fortunate—1938 was a year of rearmament for most of the participating countries and both production and imports were abnormally high; 1947 was too near the end of the war to represent a normal post-war year. As for the 1952/3 figures, these were forecast presumably in 1948/9, when conditions were not yet stable and cannot be anything better than expressions of pious hopes. The 1947 data are the most reliable and useful of the lot; they will be analysed in some detail, after filling in the important gap caused by the failure of the Netherlands to supply statistics for that year.

Discussion of the Data

General.—The general statistical position is given in Table I. Its most striking feature is that the European production of machine tools in 1947 was only 70 per cent of the 1938 production. The shortfall is almost wholly accounted for by the virtual dropping out of the Trizone of Germany as a producer.

The anticipated 1952 production is shown to be 25 per cent greater than in 1938. This is to be achieved mainly by a spectacular come-back of the Trizone as the chief European producer, with a production equal to two-thirds of its 1938 figure. How she is to increase her production sixteen times between 1947 and 1952 is not clear, and one may assume that the ambitious figures will not be fully achieved. Almost equally ambitious is the Italian bid to assume the third place as a producer by increasing her output by 50 per cent. Since the 1947 Italian figures already seem overestimates, it is doubtful whether Italy can outstrip both France and Switzerland by 1952.

The Swiss figures, on the other hand, seem both reliable and conservative: be-

Table I (In 1948 dollars)

Item	Dollars (millions)	1938	Per cent	Dollars (millions)	1947	Per cent	Dollars (millions)	1952/3	Per cent
Production:									
Total for all participating countries	200	—	100	140	—	100	250	—	100
Value and percentage of production by leading country	88·5	Trizone of Germany	45	36·7	U.K.	26	57·0	Trizone of Germany	23
Value and percentage of production by second country	38·0	U.K.	20	22·8	Switzerland	16	51·4	U.K.	20
Value and percentage of production by third country	22·5	Italy	11	21·0	Italy	15	33·3	Italy	14
Value and percentage of production by fourth country	18·0	Switzerland	9	20·8	France	15	27·6	France	11
Value of leading category of machine tools and percentage of total	80·0	Centre lathes	40	56·0	Centre lathes	40	95·0	Centre lathes	38
Value of second leading category	40·0	Grinding machines	20	28·0	Grinding machines	20	50·0	Grinding machines	20
Imports:									
Total for participating countries from all sources	47·0	—	100	63·0	—	100	53·0	—	100
Total for participating countries from U.S.A.	18·0	—	33	39·0	—	52	22·5	—	42
Principal importer, value and percentage of total	15·7	U.K.	33	20·0	France	32	10·9	France	20
Second principal importer, value and percentage of total	9·8	France	21	12·0	Sweden	19	9·5	Netherlands	18
Third principal importer, value and percentage of total	6·4	Italy	13	6·7	U.K.	11	8·9	Sweden	17
Exports:									
Total European exports to all countries	47·0	—	100	58·0	—	100	115·0	—	100
Total of which to non-participating countries	18·0	—	38	28·0	—	48	61·0	—	53
Principal exporter	19·0	Trizone of Germany	40	16·1	Switzerland	28	24·0	U.K.	21
Second principal exporter	12·4	Switzerland	26	15·5	U.K.	27	22·0	Trizone of Germany	19
Third principal exporter	11·3	U.K.	24	9·6	Italy	17	18·3	Italy	16
Machine Tools Retained:									
Total for participating countries	90·0	—	100	124·0	—	100	196·0	—	100
By leading country	70·0	Trizone of Germany	37	40·0	France	32	38·0	Trizone of Germany	19
By second leading country	42·0	U.K.	22	28·0	U.K.	22·5	33·0	France	17
By third leading country	28·0	Italy	15	23·0	Sweden	18·5	30·0	U.K.	15

My main object in this article will be to present the relevant facts to British manufacturers in a manner most likely to be useful to them for gauging the present position the past years; and that the position is not likely to be much better by the critical year 1952/3, when Marshall Aid will cease, unless some intelligent action is taken by all those concerned with production and trade in machine tools.

Clearly, the most appropriate means to this effect could have been taken if there were concerted action at European, or at least, at national levels. In the absence of a co-ordinating authority it is still possible to improve the situation by individual firms so modifying their individual future policies as to achieve more balanced national, and thus European, programmes. To do so, each firm in question must read correctly the appropriate sections of the report and appreciate the overall necessities of Europe in respect of machine tools.

*Obtainable through H.M. Stationery Office.

tween 1938 and 1947 she increased her production by 25 per cent; she thinks that by 1952 she will further increase it by 15 per cent.

In the export field there is the remarkable fact that tiny Switzerland occupied the premier place in 1947 (closely followed by the U.K.). The U.K. hopes, however, to attain the first place in 1952 by increasing her output by 40 per cent in the intermediate U.S.A. in 1952 will be three times those of 1938.

Both in 1938 and 1947 total European imports and exports were nearly balanced, but by 1953 it is hoped that exports will amount to twice the imports.

The value of machine tools retained by Europe in 1947 was only two-thirds of the 1938 amount; but it must be remembered, that in the latter year Europe was anxiously

1953 there will be an overall technological deficit of European machine tools. In other words, the output up to now, and that planned up to 1953, has been pitched too low. Sweden and France seem to be the honourable exceptions in this case, whilst the U.K. is credited with increasing her population in 1952/53 by only 30 million dollars worth. In a previous article† it was shown that by that time this country may

TABLE II

	1947	U.K.				Switzerland				Italy				France				Total for Europe
	Item	Production		Ratio dollars/ton	Exports dollars	Production		Ratio dollars/ton	Exports dollars	Production		Ratio dollar/ton	Exports dollars	Production		Ratio dollar/ton	Exports dollars	
		Tons	Dollars 000			Tons	Dollars 000			Tons	Dollars 000			Tons	Dollars 000			dollars
	Autos (total)	2,690	5,000	1,850	1,353	2,000	6,600	4,300*	4,800	50	200	4,000	—	480	1,170	2,220	80	13,384
1	Single-spindle, sliding head	80	486	6,000	—	1,100	3,200	2,900	‡2,265	10	40	4,000	—	110	300	2,700	19	4,026
2	Single-spindle, turret (bar)	1,000	1,728	1,730	540	750	2,800	3,700	2,055	10	40	4,000	—	370	870	2,400	62	5,688
3	Single-spindle, chucking	400	728	1,800	216	65	220	3,400	105	30	120	4,000	—	—	—	—	—	1,172
4	Multi-spindle, horizontal	950	1,620	1,720	417	—	—	—	—	—	—	—	—	—	—	—	—	1,626
5	Multi-spindle, vertical	260	432	1,660	184	100	390	3,900	350	—	—	—	—	—	—	—	—	822
	Gear-Cutting machines (total):	1,190	1,880	1,580	550	610	2,432	4,000	2,250	860	2,300	2,700	1,000	330	790	2,400	18	7,500
	Straight spur or helical:																	
6	Shaper type	760	1,231	1,600	345	200	620	3,100	905	390	1,030	2,700	520	230	460	2,000	—	—
7	Hobbing type	200	324	1,600	85	125	770	6,200	525	240	650	2,700	340	30	80	2,700	—	—
8	Gear tooth grinders	100	152	1,500	78	250	940	3,800	705	—	—	—	—	70	250	3,600	18	—
9	Gear-tooth finishing	90	108	1,200	43	—	—	—	—	50	135	2,700	60	—	—	—	—	—
10	Bevel type	40	65	1,450	—	35	102	2,900	90	180	485	2,700	60	—	—	—	—	—
	Grinding machines (total):	6,945	10,112	1,460	4,650	1,000	3,353	3,350	2,300	1,620	3,565	2,200	1,800	1,240	3,960	3,200	115	24,000
11	Cylindrical, plain external	1,300	1,944	1,500	972	—	—	—	—	300	660	2,200	450	200	580	2,900	—	—
12	Cylindrical, universal	680	972	1,430	486	400	1,200	3,000	910	400	880	2,200	525	600	1,980	3,300	115	—
13	Cylindrical, internal	220	324	1,470	108	100	420	4,200	280	100	220	2,200	120	100	350	3,500	—	—
14	Cylindrical, centreless	750	1,080	1,440	540	—	—	—	—	80	176	2,200	75	100	330	3,300	—	—
15	Surface	1,400	2,160	1,550	1,080	100	290	2,900	148	300	660	2,200	375	200	580	2,700	—	—
16	Thread grinders	220	324	1,470	162	140	610	1,500	560	—	—	—	—	—	—	—	—	—
17	Cam and crankshaft	750	1,080	1,440	432	30	50	1,670	48	50	110	2,200	50	40	140	3,500	—	—
18	Profile (rod cams)	38	54	1,420	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19	Gap gauge	38	54	1,420	—	15	67	4,380	48	—	—	—	—	—	—	—	—	—
20	Race track	—	—	—	—	—	—	—	—	20	45	2,200	—	—	—	—	—	—
21	Roll	900	1,260	1,400	540	—	—	—	—	150	330	2,200	75	—	—	—	—	—
22	Spline	20	28	1,400	—	—	—	—	—	50	110	2,200	30	—	—	—	—	—
23	Others	629	796	1,270	210	200	675	3,380	285	170	374	2,000	100	—	—	—	—	—
	Boring and Milling machines (total)	4,510	4,960	1,100	2,274	1,960	6,270	3,200	5,000	860	2,150	2,500	1,600	1,450	3,500	2,400	30	23,750
24	Horizontal spindle	3,400	3,780	1,110	1,944	310	700	2,260	672	600	1,500	2,500	1,180	1,200	2,800	2,330	—	—
25	Vertical spindle	600	540	900	192	200	650	3,250	544	100	250	2,500	150	250	700	2,800	30	—
26	Fine	160	172	1,080	8	300	930	3,100	390	—	—	—	—	—	—	—	—	—
27	Jig	300	390	1,300	88	850	2,780	3,280	2,540	—	—	—	—	—	—	—	—	—
28	Others	50	78	1,560	42	300	1,210	4,000	855	160	400	2,500	270	—	—	—	—	—
	Centre lathes (total)	10,000	13,000	1,300	5,600	1,435	4,065	2,840	1,840	5,360	10,000	1,870	3,500	5,000	10,200	2,040	400	48,600
29	Height of centres under 200 mm	3,500	5,400	1,540	2,240	830	2,575	3,100	1,085	1,580	2,940	1,870	1,300	1,500	3,350	2,240	110	—
30	Height of centres under 200–400mm	4,500	5,400	1,200	2,160	560	1,380	2,480	695	2,700	5,040	1,870	2,400	2,750	5,600	2,040	250	—
31	Height of centres over 400mm	2,000	2,160	1,080	180	45	110	2,450	60	1,080	2,020	1,870	800	750	1,250	1,670	40	—
	Planers (total)	2,207	1,829	830	1,050	35	70	2,000	—	1,400	2,800	2,000	700	780	1,170	1,500	12	6,170
32	Double column	2,000	1,575	790	864	10	20	2,000	—	1,200	2,400	2,000	620	700	1,000	1,430	12	—
33	Single column	207	254	1,230	186	25	50	2,000	—	200	400	2,000	80	80	170	2,120	—	—
	Grand total	27,500	36,700	1,335	15,500	7,040	22,800	3,240	16,100	10,150	21,000	2,070	9,600	9,280	30,800	2,240	650	123,380

period. How such a large increase is to be achieved in view of the slow rate of progress since the peace is not clear. However, as will be shown, the position of the U.K. as a producer of machine tools is strong at present.

The statistics also show that Sweden has become an important manufacturer of machine tools, rising to the fifth place in 1947, and thus beating Belgium.

While of no great significance to the overall European position, we must also record the interesting fact that Denmark's production, which, up to 1938, was very small, had grown quite considerably by 1947; apparently she hopes for a further doubling in her output by 1952. She is thus the country which anticipates the largest growth of her trade in the years under review with a six-and-a-half-fold increase.

The distribution of the European output by categories for all three reference years is remarkably constant, centre lathes accounting for 40 per cent of the production and grinding machines for 20 per cent. By 1953, however, Europe hopes to improve its relative output of gear-cutting machines. This notwithstanding, it is still anticipated that the imports of these machines from the

building up its machine tool population. The report shows that by 1953 there will be the same rate of retention of machine

TABLE III

Sub-category	1947 Value of Exports in dollars 000	
	Swiss	British
Automatics:		
One-spindle, sliding-head type	2,265	—
One-spindle, turret-head type	2,025	540
Multi-spindle, vertical	350	284
Gear Cutters:		
Shaper type	905	305
Hobbing type	525	85
Gear-tooth grinders	705	78
Bevel type	90	0
Boring and milling machines:		
Vertical spindle	544	192
Fine boring	390	98
Jig boring	2,540	88
Grinding machines:		
Cylindrical, universal	910	486
Cylindrical, internal	280	108
Thread grinders	560	162

tools as in 1938. However, even this figure seems inadequate for technological progress and it thus looks as if between 1945 and

need as many as 44,000 new machine tools; these would be worth about 100 million dollars at 1948 prices. If this requirement were met British production would have to amount to 130 million dollars and not just over 50 million dollars, as forecast in the report. This would mean trebling the 1947 output at least.

In 1947 one-third of the machine tools retained in Europe were centre lathes and one quarter were grinding machines. The high proportion of centre lathes is significant, as they may be regarded as technologically less advanced than other classes (even if turrets and capstans are included in that category, on which point the report is silent). In the case of the U.K., however, the proportion of centre lathes retained was only one quarter and it may be assumed that the restocking of our machine tool population, though slower than that of other European countries, is technologically somewhat more advanced.

Analysis of the 1947 *Trade by Categories.*—Table II gives a resumé of the 1947 trade of the four principal European countries:

† "The British Machine Tool Industry." "The Engineer" December 17th & 24th 1948.

U.K., Switzerland, Italy, France. In that year these countries produced 54,000 tons of tools, valued at 102 million dollars, the average price per ton being thus 1900 dollars. The U.K.'s share of this output is 50 per cent by weight, but only 36 per cent by value because the average price per ton of British machines was only 1335 dollars. On the other hand, the average price of Swiss machines was 3240 dollars, i.e., the Swiss were able to command two and a half times the price per ton we did; Italian and French machines were also more expensive per ton. Does this mean that British machine tools offered better value than those of the other three countries? Or does it mean that our designs are too heavy and the machines carry an excess of dead cast iron? Or does it mean that British machines are technically less advanced and therefore fetch lower unit prices? No doubt all three factors apply in various cases but a closer analysis of the figures indicates that the first factor is the least likely or important one. Thus, it is obvious that the Swiss were highly competitive and were obviously able to offer good value because not only were their total exports greater than ours but in thirteen sub-categories of machine tools they were the absolutely predominating exporters, as is shown in Table III above.

The real importance of Britain in the machine tool trade becomes apparent when one considers the production figures, as given in dollars in Table II. She is the largest manufacturer of thirteen sub-categories and the second largest of twelve further ones, whereas Switzerland occupies nine premier and six second places; Italy and France are poor third and fourths, respectively.

None the less, the position leaves but little room for complacency to British manufacturers. To retain their important position, British makers will have to do much development work and to rationalise production still further. Our machine tools must be continuously modernised, the volume of production must be much increased and the prices of some varieties (e.g., single-spindle, sliding-head automatics) substantially reduced, to make them competitive.

An Engineer's Diamond Wedding

On Wednesday of last week, the "Diamond" wedding was celebrated of Captain and Mrs. A. E. Penn. Captain Penn has for thirty-eight years been Honorary Secretary of the Institution of Engineers-in-Charge and, despite his now very considerable age—he is eighty-three—he not only still maintains a keen interest in the progress of events, but still continues to guide the affairs of the Institution. The Institution of Engineers-in-Charge undoubtedly largely owes its prosperity to the enthusiasm of Captain Penn. For his genial personality has gathered round him a whole host of friends and he has always had a very happy knack of keeping around him a number of men as enthusiastic in the affairs of the Institution as himself. Those men include his son, on whom his mantle has so largely fallen. All those very many people who count themselves amongst the friends and acquaintances of Captain Penn will join with us in congratulating him and in wishing him many more years of work for the Institution that he has served so well.

The British Hydromechanics Research Association has now occupied its new laboratory and offices, the address of which is Netteswell Road, Harlow, Essex (telephone, Harlow 2366). The London office of the Association has been closed.

Production of Tensile Test Specimens

By H. JENNINGS, A.M.I.Mech.E., A.M.I.P.E.

THE strength and elastic properties of a material are determined by the simple tensile test in which a specimen of standard shape is subjected to an axial load. In routine commercial testing the maximum stress and percentages elongation on gauge length and reduction in area at fracture are the values required, while by using an extensometer the extension can be ascertained over the full range of load. The specimens used are destroyed in each test so that an unrestricted supply is desirable if students at a college are to become experienced in carrying out these tests. The manufacture of sufficient specimens on a production basis became a serious difficulty at the Technical College, Bradford, owing to the large present number of students in the Mechanical Engineering Department. At the request of the Head of the Department, J. G. Jagger, M.A., M.Sc., Wh.Sc., an investigation into possible methods of manufacture was therefore carried out.

The standard specimen usually employed (Fig. 5) is 0·564in diameter over a parallel length of 2·25in, the actual gauge length being 2in. There is a transition curve leading from this central portion to the collared ends, by which it is held in the testing-machine shackles. Normally the specimen is turned between centres and possibly ground on the test diameter. An operator of average ability, using standard equipment, can produce a single specimen to these dimensions in one-and-a-half to two hours. This period applies where an individual specimen is required for a particular test. When machined in this way in batches an operator can achieve a production rate of about two specimens per hour.

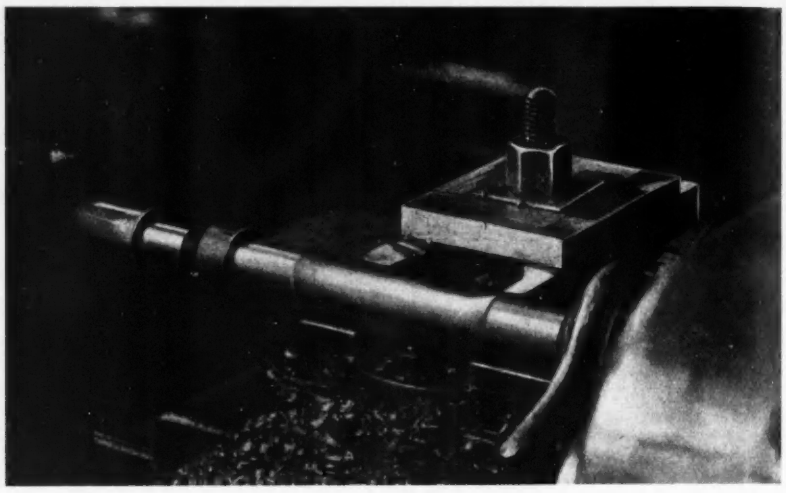


Fig. 1—Turning Collared Ends

To increase the rate it was finally decided to replace the turning of the gauge length and transition curves by a single milling operation. A photograph of the first trial is shown in Fig. 3. The machine is a No. 1 N.A. Parkson universal milling machine, with a standard 18 per cent tungsten high-speed side and face cutter, 6in by ¼in by 1¼in bore, with twenty teeth, cutting without arbor key at 93 r.p.m. During development of the method the work was rotated by hand either with the indexing crank through the 40 : 1 dividing head-gear, or by means of a special handle connected directly with the dividing head spindle, through the change gears behind the dividing head. The work is rotated at approximately 2 r.p.m. and at the same time the vertical

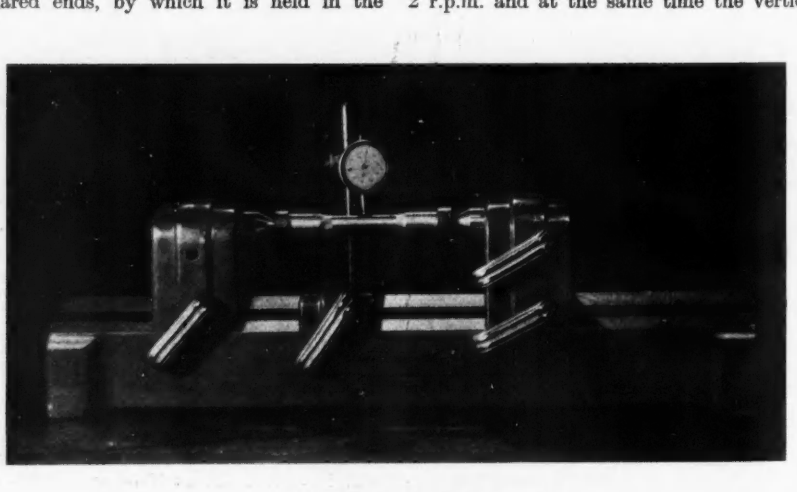


Fig. 2—Final Inspection

feed is engaged at ¼in per minute. One side of the cutter is offset from the work axis by half the diameter of the gauge length. The parallel length of gauge diameter and the transition curves are then developed in the one operation. The cut is made by the peripheral edges of the teeth of the cutter and the cutting speed of 150ft per minute with an effective feed of 0·0035in per tooth produces surfaces of adequate quality. There is, however, a deviation from roundness of as much as 0·006in. The milling time is only five minutes each.

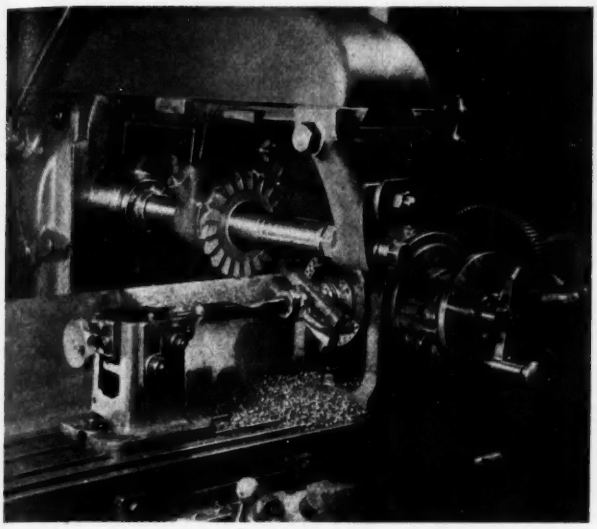


FIG. 3—MILLING A TEST SPECIMEN

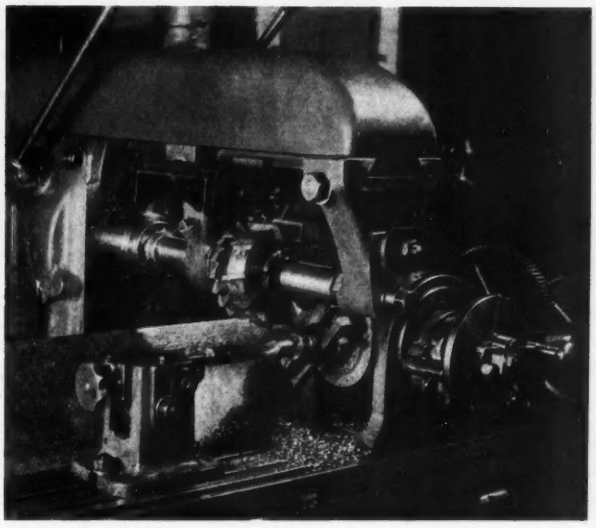


FIG. 4—MILLING A SPECIMEN WITH TWO CUTTERS

The roundness can be improved by mounting two cutters side by side, as shown in Fig. 4. The work, as before, is fed vertically between them as it is slowly rotated. The second cutter cuts on the radial tooth-edges and serves as a finishing cutter. With the same speeds and feed as previously, the surface finish is improved and the roundness brought within 0·002in. The cutters actually used were those available and it is considered that two identical cutters of substantial width, e.g., 6in by 1in by 1¼in bore and twenty teeth, would give good service. In use one batch of components could be rotated in one direction and the next batch in the reverse direction. The cutters might then be interchanged and the process repeated to make full use of all cutting edges before regrinding was necessary.

The collared ends of the specimens are produced separately by turning. Two standard high-speed steel-bar turning tools of shapes 9 and 10, with 20 deg. true rake, are mounted together, as shown in Fig. 2, one pass to the right and one to the left being sufficient. A cutting speed of 88ft per minute and feed 0·02in per revolution for the 0·125in deep cut can be used.

The final grinding operation is required only to correct the slight ovality. It is done on a Churchill Universal machine and the wheel has a small corner radius at each side. The amount removed in grinding is 0·003in to 0·005in on diameter.

Inspection of the finished pieces can, of course, be done by the use of such bench centres as those shown in Fig. 2. The dial gauge reads to 0·0001in per graduation and shows roundness, concentricity and variation, if any, from the correct diameter. Additional gauges could be mounted to check the collar diameters at the ends at the same time.

Fig. 5 shows the various stages in production and the machining times have worked out as follows:—

Operation	Machine	Time (machining only)
(1) Cut-off ...	Power saw	1·5 minutes
(2) Centre drill	Centring machine ...	1·0 minutes
(3) Mill	Universal miller ...	5·0 minutes
(4) Turn	Centre lathe	2·0 minutes
(5) Grind	Universal grinder ...	0·25 minutes
Total time		9·75 minutes

Operations 1 and 2 are also done on a small capstan lathe when available. Using these methods, the rate of production, including handling times, was increased to four per hour, the tools used at all stages being standard and readily obtainable. Machine setting is simple and direct and the setting time a very small percentage of the total time.

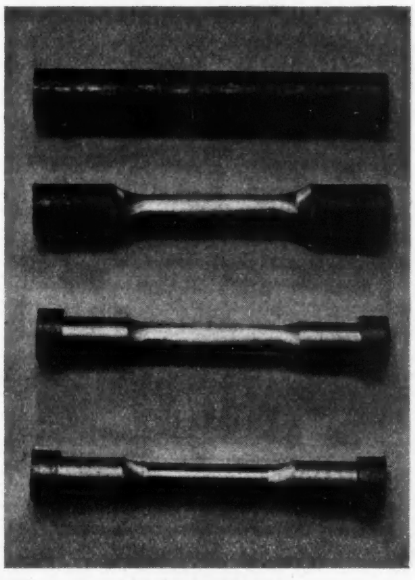


FIG. 5—SPECIMENS

These results compare so favourably with other methods of manufacture that it has been considered worth while to install a power drive to replace manual rotation of the workpiece during milling. It is proposed to replace the dividing head with a fabricated headstock containing a 30 : 1 worm and wormwheel, which happens to be available. A single vee pulley on the cutter arbor will drive a suitable vee pulley on the worm shaft. This arrangement will ensure that the workpiece revolves all the time that the cutter revolves, thus avoiding any tendency to produce milled flats. To allow for variations in pulley centre distances owing to the vertical table feed, a jockey pulley would be used.

Telcon Centenary

IT is a matter of deep regret to us that, owing to the dispute in the printing trade now ruling, we can afford to make only this very short reference to the Centenary Celebrations of the Telegraph Construction and Maintenance Company, Ltd., of 22, Old Broad Street, London, E.C.2.

Actually that company traces its beginning to an agreement made between Charles Hancock and Henry Bewley in 1845 that led to the birth of the Gutta Percha Company which became eventually the Telegraph Construction and Maintenance Company. But 1945 was not a year convenient for celebrating a Centenary. The celebrations were therefore deferred to coincide with the centenary of the first laying of a telegraph cable across the English Channel. That cable was made by the Gutta Percha Company and the story of its laying (and of very much else besides) is told in a book "The Telcon Story 1850-1950" that lies beside us as we write.

On August 28th, 1850, telegraph communication was first established between England and France. Sixteen years later the Telegraph Construction and Maintenance Company produced the first successful Atlantic cable. Since then the company and its associate Submarine Cables, Ltd., have manufactured nearly half-a-million nautical miles of submarine cable representing about 90 per cent of the world's submarine cable installations.

To celebrate its centenary the company arranged an interesting programme of events for its guests. On Tuesday last there was a river trip to Greenwich, followed by a tour of the works; and on Wednesday a tour was arranged by boat and coach to Windsor. In the evening there was a very well attended dinner at the Dorchester Hotel.

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AN EMERGENCY ISSUE

As we went to press last week we were already aware that this issue must necessarily be a small one, much smaller inevitably than last week's. For even had it proved possible for the London Master Printers' Association and the London Society of Compositors to settle their differences sufficiently rapidly to enable the men to be quickly recalled some days work at least must have been lost before that recall became effective. In fact, however, representatives of the two sides to the dispute only came together, under the ægis of the Ministry of Labour and National Service, last Monday; and, alas, through the intransigence of the Society nothing was accomplished. There was no comfort there. Nor can we find much comfort in the decision of the Ministry to set up a Court of Enquiry into the dispute. For many days must elapse before the enquiry can be completed.

So this has had to be an emergency issue. What is worse is that there is no present prospect of printing larger issues. Moreover the amount of "news" that we can print is severely limited. Since we are not alone, for the bulk of the trade and technical press of this country is involved, and since it is not impossible that if the dispute continues printing may be brought completely to a standstill, the loss to the country is likely to be severe. The chief means of spreading that trade and technical information, which maintains the flow of new ideas, brings about improvements in processes, initiates discussion, increases knowledge about new machines and products, provides up-to-date facts about the state of markets and records changes in Governmental practices and orders is being dried up. It is maddening to us that the cause of the trouble is now quite clearly mere obstinate intransigence. For what can the L.S.C. reasonably hope further to gain by its refusal to be conciliatory? The Ministry has been involved. A Court of Enquiry is to be set up. One word from Mr. Willis of the L.S.C. could set the compositors to work again. He will not pronounce it.

THE PERFORMANCE OF NATIONALISED INDUSTRIES

IN our issue of August 25 we made reference to the Labour Party statement then just issued under the title "Labour and the New Society." We remarked that in that part of the document which refers to the public ownership of industry the Labour leaders had become, if only implicitly, critical of nationalised industry. At about the time when we were going to press with those remarks, another document concerned with nationalised industries was issued. It has been prepared by the General Council of the T.U.C. as a Supplement to the Report of that body to its delegates and it is a far more interesting and instructive document than the party political pamphlet reviewed last week. For though it undoubtedly shows that the trade union movement as a whole still, unrepentantly, favours the extension of national ownership of industry, it also reveals a recognition of the fact that nationalisation is unlikely to appeal to the people of this country if presented to them merely as a part of Socialist doctrine. It is, in fact, bluntly remarked that "if further extensions of nationalisation are to be justified and acceptable to the community, the existing schemes must be shown to be successful."

The T.U.C. General Council is thus demonstrated to be amongst those many people who are now studying how best to judge the performance of nationalised industries. But how is that performance to be judged? According to the General Council publicly owned industries are to be expected to do more than merely avoid making a financial loss. They are to give "the best possible service at the least real cost to the community," and they are to improve "standards of wages and conditions for workpeople in the industry." In addition, they are to help to bring about "a more equitable standard of living, increased public control over the economic system" and "the maintenance of full and stable employment." They are also to create "increased industrial democracy," by which is meant "a great extension of the part that workpeople can play in the running of the industries in which they are employed." These are wide grounds upon which to base a judgment of the performance of nationalised industry. Unfortunately, they are also uncertain grounds. For it is surely a fact that all the latter of these purposes might well be judged to be well served even if the first of them, "the best possible service at the least cost to the consumer" was not. The chief defect of a nationalised industry is that it is a self-contained monopolistic body. It could therefore grant higher wages, better conditions, full employment, and increased participation of workers in management, even though it were an inefficient organisation, through the simple means of passing the cost on to the consumer. Indeed, it might conceivably be already argued that in the coal-mining industry just those things have already been granted by just that method! It seems, then, to us, as we think it will seem to many others, that in judging the performance of nationalised industries, chief account must be given to the first of the purposes mentioned by the T.U.C. General Council. Can nationalised industries give "the best possible service at the least real cost to the community"? Are they, in fact, likely to do so?

Unfortunately, though it is easy enough to judge whether a public industry is improving standards of wages and conditions of work, maintaining full employment and the like, it is very much more difficult to come to a true judgment about its efficiency. For—it is one of the chief defects of publicly owned industry—there is no standard with which to compare its performance. It is true that the cost of its products in relation to their quality should provide a measure. It is true also that the cost of its products can be compared with that of the similar products of other nations. But, unfortunately, that comparison is usually vitiated by the differing conditions in the two countries. Winning coal out of the easily worked mines in America, for instance, is so much simpler a process than it is in British mines that comparisons of cost are without value, and how is one adequately to compare transport costs in Britain with those of France or Switzerland, where traffic conditions are wholly different? In a recent issue of *The Political Quarterly*, it was pointed out that "if the public corporations work well and efficiently; if they display creative energy and imagination; if they show a proper concern for the divergent interests of consumers, employees and the taxpayers; if they avoid the traditional defects of monopolies; if they excel in applying scientific research and development, then in due course an ever-increasing proportion of the nation will accept public enterprise as a wise method of conducting a larger share of the economy." That is very true and very well expressed. But how are those qualities to be measured? Are they not, indeed, all qualities that can be measured only by reference relatively to something else? When competition exists either directly or indirectly (as, for instance, when there were four main line railway groups not directly in competition) we can say that this concern or that clearly excels in earning profit, in offering its goods cheaply, in providing particularly good conditions for its workpeople, and so forth, implicitly criticising the rest for their failure to maintain such standards. But with what can we compare the performance of monopolistic nationalised bodies? How, then is their performance to be judged? How, indeed! For how can we tell what progress might have been made under the spur of competition had private competitive industry been allowed to continue? Is it not, in truth, the fact that we never shall be able to tell? In the absence of really gross inefficiency or really remarkable success is it not likely that the success or failure of nationalised industry will remain for ever unproved, for ever a matter of opinion and for ever a matter of dispute in the councils of the State?

We should like to express our appreciation to our printers' apprentices for their effort towards producing this issue.

Literature

Elements of Internal Combustion Turbine Theory. By H. T. ADAMS. Cambridge University Press. 16s.

THE author of this book was for some time Director of Studies to Power Jets, Ltd., under the Ministry of Aircraft Production, and as such was responsible for the training in aeronautical gas turbine engineering of numbers of British and Dominions Service and civilian personnel. He is now Senior Lecturer in Mechanical Engineering at Canterbury University College, New Zealand, a position in which he must find it difficult to keep abreast of current developments in gas turbine engineering. Nevertheless, his book of some 180 pages is closely packed with information which will be of value to the post-graduate student in engineering or to the prospective designer.

In his preface the author states that a reasonable mathematical background and some knowledge of aerodynamics is assumed, though a chapter on fundamental theory is included. This statement sets the seal on the whole book, for it is on the mathematical theory of the design and performance of gas turbines and their component parts that the book centres. It is gratifying in this respect to find that the author, unlike the writers of several recent books on gas turbines, is prepared to devote a good proportion of his book to the design theory, not only of compressors and turbines, but also of heat exchangers and to the consideration of mechanical problems of disc and blade stressing, blade vibration and critical speeds of rotors.

One of the weakest features of the book, especially in these days of increasing interest on industrial gas turbines, is the small amount of space devoted to the more complex type of gas turbine which is required for such duties. It is fortunate that the one example of such an engine about which much is said refers to a hypothetical lay-out which whilst undoubtedly complex, is also equally unrealistic.

This criticism apart, however, the book is one which can be well recommended to the type of reader for whom it is specifically prepared.

The Dynamics of Real Fluids. By E. G. RICHARDSON. London: Edward Arnold and Co., 141, Maddox Street, W.1. Price 21s.

THE task of an author who entitles his book "The Dynamics of Real Fluids" is a tremendous one, if it is at all a possible one. Such a title implies a steadily-developed discussion of the differences in behaviour of fluids as they are observed and of "ideal" fluids as they may be calculated. These differences, the reasons for them and methods for predicting them have received steadily increasing attention since the turn of the century, since when the importance of applied aero- and hydro-dynamics has multiplied over and over again.

Dr. E. G. Richardson, one feels, has set out to give a bird's-eye view of the subject implied by his title and it is a pity that he did not find it necessary to explain in an introduction what sort of lens his bird's-eye possessed, the height of the bird and lastly the skill of the scanners of the photograph print. One can say at once that his book is very interesting to read, but one has serious doubts as to its use as a text-book for students for whom, of course, it may not be intended. The author's intentions not being clear, one seeks guidance in the headings and length of the first three chapters and finds: i, The Classical Approach, fifteen pages; ii, Fluids of Small Viscosity, forty-six pages; iii, The Flow of Compressible Fluids, nine pages. There seems a good deal of unbalance here, and this impression is confirmed by reading these chapters. For example, only eight of the first chapter's fifteen pages are about potential flow, while in the second chapter there is an unnecessarily detailed account of the stability of the potential flow Karman vortex street. From Chapter III, the student might easily get the impression that the linearised theory of flow in a disturbed uniform supersonic stream forms the main bulk of supersonic theory.

There appear to be many small inaccuracies which irritate the expert and puzzle the student. In Chapter I, the coefficient of viscosity is η which is not usual and which competes with μ later on in the book. The derivation of the stress-strain relationship for a fluid is very far from clear, even if it is not quite misleading, and the statement of the equation of continuity, page 4, is incorrect. The footnote on the "total" rate of change, page 4, is incomplete and there are at least two misprints. This sort of mistake inevitably detracts from the value of the book. One feels that Dr. Richardson could have written a much better book about his own researches which receive considerable mention in this book.

Traité Théorique et Pratique des Engrenages, Vol. II. By G. HENRIOT. Paris: Dunod, 92, Rue Bonaparte, (VIe). Price 1,700 Fr.

THE literal translation of the title of this work, "A Theoretical and Practical Treatise on Gears," may not perhaps indicate its precise scope, and the first volume, which deals with theoretical considerations, is not yet available for review. The second volume here considered, is concerned primarily with gear manufacture.

The greater part of the volume is taken up by a statement of the principles of generation, as applied to all the types of gear in common use, and by descriptions of representative gear-cutting, grinding and shaving machines. These include machines by Barber-Colman, Fellows, Gleason, Lees-Brodner, Maag, Michigan, National Broach and Machine Co., Niles, Parkinson, Sykes, and others, and in many cases are accompanied by kinematical or geometrical analyses, diagrams of the internal gearing of the machines, sections showing details of construction, formulæ for change-gears and other machine settings, and methods of sharpening cutters.

A section of more than fifty pages deals with gear metrology. It includes an analysis of the types of error to which gear teeth are subject, and describes a variety of apparatus and methods for measuring errors of pitch, profile, tooth spiral and eccentricity. A shorter section discusses heat treatment, and the volume closes with illustrations of reducing gear units and a brief treatment of ancillary subjects, including lapping, burnishing, and lubrication.

To the present reviewer's knowledge, no similar collection of analytical descriptions of gear-cutting and finishing machines has hitherto appeared in book form, and consequently this book should be of special interest to those concerned with the design and operation of such machines. It is, of course, inevitable that, in a subject having so many ramifications, completeness of detail is impossible, and one who is already a specialist in, for example, the use of Gleason machines, may be conscious of the omissions. But others whose interest is more general will in it find much of interest and value.

It ought also to be observed that, although available only in the original French, the style is simple and lucid and a very modest knowledge of French, together with a few special terms in machine-shop and gear vocabulary, will enable its contents to be understood.

Roads: Their Alignment, Lay-out and Construction. By R. G. BATSON, M.I.C.E. London: Longmans Green and Co., Ltd., 6 and 7, Clifford Street, S.W.1. Price 21s.

IN this volume, which is intended as a guide for the civil engineering student, a concise and comprehensive introduction to modern practice in highway construction is given. The author is well-known for his work in this subject, and was at one time in charge of the Road Research Laboratory. Road construction is a problem of wide interest, and the provision of a modern road system in this country is still a much debated topic. However, highway engineers in general agree that such a system is essential, and this point of view has been adopted in this work. Whilst avoiding undue controversy in what is essentially a textbook, the author clearly states the need for modern highways in the first chapter, where he states: "The highway engineer would do well to study the principles and practices of railway engineering—which have been the result of experience in providing for the safety and convenience of the public—in deciding upon the policy to be adopted in constructional design and lay-out of the highway . . . Roads are provided out of public funds, but the public have not yet realised that if safety and progress are to be achieved the principles insisted on in railway working should also be applied to roads. The main problem is the segregation of through and high-speed traffic and this involves the construction of roads for the special use of such traffic and provided with fly-over junctions, clover-leaf junctions and bridges or subways for pedestrian and cycle traffic."

This first chapter serves as a general introduction to the subject, giving in addition to an outline of modern requirements, a brief account of the history of the British road system, and of the types and classification of roads. The procedure in developing a new road scheme is explained, details being given of surveying methods, working drawings, super elevation, transition curves, and so on. The design of road junctions is dealt with in detail, with numerous diagrams, and there is also a chapter on the general lay-out of the road. Further chapters give details of the common types of construction and there are notes on private street works, contracts and specifications. The last chapter is on road bridges.

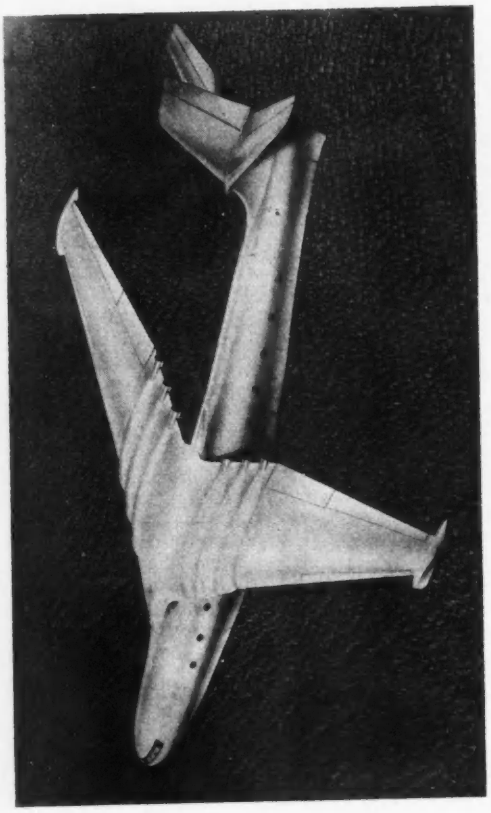
BOOKS RECEIVED

Foundry Sand Control. By W. Davies. Sheffield: The United Steel Companies, Ltd., 17, Westbourne Road, Sheffield, 10. Price 30s.

A Guide to Precis Writing. By F. J. Fielden. London: University Tutorial Press, Ltd., Clifton House, Euston Road, N.W.1. Price 6s.

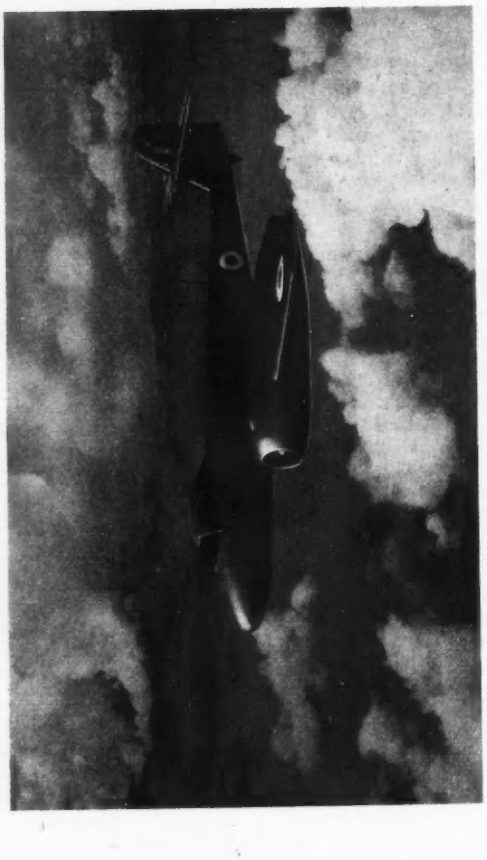
West Highland Steamers. By Christian Leslie Dyce Duckworth and Graham Easton Langmuir. Second edition. London: Richard Tilling, Publisher, 106, Great Dover Street, S.E.1 Price 15s

S.B.A.C. FLYING DISPLAY



SAUNDERS ROE "DUCHESS" MEDIUM-RANGE JET FLYING BOAT

AVRO "707 DELTA WING" RESEARCH AIRCRAFT



GLOSTER "METEOR MARK 8" WITH SAPPHIRE ENGINES

WESTLAND WYVERN "TF2" WITH LAMINAR FLOW WING

The S.B.A.C. Flying Display and Static Exhibition

No. I

FARNBOROUGH is once again the focal point of world aviation interest on the occasion of the eleventh annual flying display and static exhibition of the Society of British Aircraft Constructors. This exhibition opened on Wednesday, September 6th, to the Society's guests and will be open to the public on Saturday and Sunday, September 9th and 10th. Visitors to Farnborough this year could hardly expect to find that the aircraft industry had produced in the last twelve months anything bigger than the "Brabazon" or faster than the "Comet"—or indeed any surprisingly new machines—after the remarkable display of new aircraft presented last year. Rather has the industry, this year, been engaged on a process of consolidation and many of the flying exhibits are later Marks or production models of machines first seen at previous displays. The dearth of new military prototypes, sonic and other research aircraft can, no doubt, be attributed to security considerations, but from this present assembly of aircraft it is possible to note trends in design which are increasingly becoming characteristic of the new forms of high speed aircraft.

Details of wing sections are not generally released but there is evidence of improved slotted flap designs to induce a degree of natural boundary layer control. It is principally by this means that the lift coefficient of high speed aerofoils can be temporarily increased in the low speed range, without recourse to variable incidence wings which are mechanically undesirable. We hope to refer later to experiments conducted by the Handley Page Co., on the "Hermes" Marks IV and V aircraft into methods of forced boundary layer control. But it is difficult to report on the efficacy of these devices at present, as few firms have specified minimum speed flying characteristics. A "laminar" flow wing form is fitted to the Westland Wyvern naval strike fighter. Apart from removing the maximum wing camber well back from the leading edge, an extremely high finish is required to ensure laminar flow in the boundary layer, which is reputed to be less than ·01 inches thick It is claimed theoretically, that the drag of such a section can be reduced by 90 per cent by this method.

To delay the onset of sonic velocities at the point of maximum wing camber, in advance of the aircraft speed, present practice favours the method of presenting the leading edge at an angle to the airflow, and this swept back wing form is noticeable on several exhibits. It is seen in an engraving opposite, fitted to the projected "Duchess" flying boat manufactured by Saunders-Roe. This method of increasing the critical Mach number, whilst delaying the compressibility effect at subsonic speeds, introduces a tendency for the outside wing surface to stall prematurely. This defect, along with a low C_L max, raises the stalling speed and consequently, both on this aircraft and the DH. 108 (Swallow), leading edge slots can be seen fitted. That high aspect ratios are no longer regarded as an advantage can be seen from a number of machines. The ratio of the "Canberra" is now 4 : 3 whilst that of the Avro "delta wing" exhibit is 1. An illustration of the original "delta wing" aircraft is shown opposite. It has now been slightly modified and incorporates a longer nose. The new design follows from an extension of the swept back theory and is regarded as more suitable for supersonic speeds. This aircraft has presented many control problems and the flying characteristics generally have yet to be fully investigated. Apart from its leading dimensions no further information has been released.

The effect of the attainment of high Critical Mach Numbers on fuselages is well shown by the exceptionally slim proportions chosen on a number of machines to reduce local increases of velocity over the skin. Wings are commonly attached to high speed aircraft without root fillets. Fuselages are mainly pressurised and conditioned to operate at ceilings ranging from 25,000ft to 40,000ft. Thermal de-icing without the use of separate combustion chambers is an advantage now available through the introduction of turbine propulsion for aircraft. Tricycle undercarriages are now almost universally fitted.

The extent to which the reciprocating piston engine continues to be superseded by the gas turbine is revealed by the lack of evidence of any further development of the piston engine in Great Britain, although in America a production engine embodies a radial arrangement of pistons exhausting to a single-stage turbine using a slight degree of reaction. It is made apparent at this exhibition, that the further use of the piston engine in this country has been relegated to light aircraft and feeder line transport services. Even in this sphere that engine may be challenged in the near future. The parallel development of centrifugal and axial flow compressors has continued. Two new jet turbines have been announced, and one, the Armstrong Siddeley "Sapphire," develops 7200lbs static thrust which is equivalent to about 14,000 b.h.p. at maximum flying speed. It is now the most powerful unit to have passed the 150 hour running stage. A Meteor powered by the "Sapphire" will give a demonstration during the display, and one of these machines is illustrated on the opposite page. With so much thrust available it should now be possible to obtain transonic speeds whilst climbing, and to penetrate deeply into the supersonic speed range.

The Rolls-Royce "Dart" and Bristol "Proteous" propeller turbines have now been fitted to the "Viscount" and "Hermes" V airliners respectively, both of which have been previously described in our issues of September 10, 1948, and January 6, 1950. The "Viscount" is already on schedule service, and the "Hermes" is shortly to be introduced. It is claimed that these machines can operate with virtually the same fuel consumption formulæ as piston engines, and that therefore they can be accommodated without priority in existing traffic control systems. The performance of the "Comet" is now well known, but the more general use of pure jet civil land planes is still affected by their high fuel consumption characteristics at circuit speeds and heights. The problem of receiving and despatching these aircraft in numbers during all weathers without "stacking" or delay, and at speeds up to 500 m.p.h., does not lend itself to a simple or immediate solution. But this difficulty hardly arises with the operation of jet flying boats, and we have already referred above to the 130,000lb "Duchess" flying boat, which has six de Havilland "Ghost" jet turbines giving a cruising speed of 500 m.p.h., and a range of 31,000 miles at a calculated cost of a penny-farthing to twopence per passenger per mile.

(To be continued)

The British Association

No. I

THE meeting of the British Association for the Advancement of Science, which, this year, was held in Birmingham, began on Wednesday August 30th, and continued until Wednesday last, September 6th. The President was Sir Harold Hartley, F.R.S., and his address, entitled "Man's Use of Energy," was printed, in abstract, in our last issue. In the appropriate Sections, man's use of energy may be regarded as the underlying theme of many of the papers and a very wide field in this respect was covered. Moreover, as energy in the service of man is the topic suggested by UNESCO for world-wide study and discussion in 1950, an exhibition illustrating this theme was arranged by the National Coal Board, the British Gas Council and the British Electricity Authority, in conjunction with the Birmingham Municipal Museum. It was staged in the University at Edgbaston—where the various Sectional meetings were held—and the exhibits illustrated modern developments in the use of coal, gas and electricity, one section dealing with the development of the steam engine and its connections with Birmingham. The usual public lectures, too, covered the same subject and dealt with energy and civilisation, Birmingham and the industrial revolution, man's use of solar energy, the production and distribution of power, and gaseous fuels and their significance in the future.

Section G (Engineering) was presided over by Professor Andrew Robertson, F.R.S. (lately Professor of Mechanical Engineering, Bristol University), and the subject of his presidential address to the Section was "A Chapter in Bridge Engineering a Century Ago." An innovation in this Section this year was that the proceedings were divided into simultaneous sessions A and B, an arrangement which made it possible to deal comprehensively with particular subjects in the two sessions, a distinct advantage over the usual practice of a series of papers on mixed subjects for which, in the past, there has been totally inadequate time for useful discussion. The new arrangement was planned to remedy this defect. The presidential address to Section G this year was delivered on the first day of the meeting instead of later on, as has been the practice for the past few years, and it was appropriately followed by a paper in Session A of the Section on "Bridge Building To-day and To-morrow," by Dr. G. Roberts, of Messrs. Freeman Fox and Partners, consulting engineers.

As might be expected, nuclear power development was also discussed. Sir John Cockcroft gave a general review of the progress made towards the development of nuclear power since the B.A. discussion at the Dundee meeting two years ago, and there was some information from workers in this field with regard to the industrial use of radioactive isotopes.

Industrial matters were considered, particularly in regard to the appointment of Development Councils for a number of

industries, socio-psychological factors in productivity, and the importance of higher technological education in relation to industrial productivity. Mechanisation in agriculture was another subject receiving prominent attention and from the engineering and allied point of view it is perhaps true to say that a more varied and topical programme has not been arranged for a number of years. Moreover, Birmingham, being such a centre of engineering activity, the opportunity for visits to works was considerable and a larger number than usual were arranged.

It may be mentioned that the 1951 meeting will be held in Edinburgh from August 8th to 15th, under the Presidency of H.R.H. The Duke of Edinburgh, and will be one of the principal scientific events in the programme for the Festival of Britain.

(To be continued)

The T.U.C. Presidential Address

In the course of his presidential address to the 82nd Annual Trades Union Congress, which opened at Brighton on Monday last, Mr. H. L. Bullock said that trade unions under the guidance of the T.U.C. had always co-operated when and where they could along lines of policy formulated by the General Council. During the past five years, there had been good understanding and co-operation with the Government and the great body of the British people had gained the benefit. But, Mr. Bullock continued, the claims of some sections of industry had not been reasonable or practicable in the circumstances of the time; nevertheless trade unionists generally had shown balance, good sense and understanding.

Slowly but surely, Mr. Bullock went on to say, the nation was emerging from the economic chaos and industrial dislocation created by total war. There had been good reason to hope, until the war clouds gathered again in recent weeks, that the time was at hand when a little more elasticity in wages and the improvement of conditions could be exercised. Good profits had been made by industrialists, though it was true that the Chancellor of the Exchequer took at the present time about 65 per cent of all profits made, and probably still heavier taxation would have to be levied. But, Mr. Bullock claimed, the burden upon the workers must be eased, as it was not at all their fault that our industries had at times been unable to compete successfully with those of other countries in some of which mechanisation had been carried much further than in this country. He thought that responsibility rested upon employers in this country to plough back profits into industry in such sufficiency as to ensure the successful competition with other countries, without exploiting the workers. It was satisfactory to note, Mr. Bullock added, in the industries which had been transferred to public ownership that mechanisation was going on apace. It was bound in due time to show results that would satisfy any impartial person.

Solar Energy

In the course of a lecture on "Man's Use of Solar Energy," before the British Association last week, Dr. A. Parker said that at the present rates of production the quantity of petroleum oil was sufficient for the world's needs for only about twenty-five years. He considered that even with new resources, which would almost certainly be discovered, there would probably be difficulty within fifty or 100 years in meeting the world demands for petroleum. Dr. Parker said that the earth had received and was still receiving an enormous amount of energy from the sun. This energy was available in two forms, "capital" and "income." In the energy capital, there was the terrestrial heat, with which the earth was originally endowed by the sun, and there was the store of fossil fuels—coal and lignite, petroleum and natural gas, oil shale and peat. The store of terrestrial heat was equivalent to the energy of combustion of 500 trillion (million million million) tons of coal, but it was mostly so far below the earth's surface that it could not economically be harnessed to meet man's needs. Of the known resources of fossil fuels, which are equivalent to 6 million million tons of coal, 97 per cent occurs as coal and lignite, 1 per cent as peat, and less than 1 per cent as petroleum and oil-bearing shale. At present rates of production, the coal and lignite which could be produced economically were sufficient for the world as a whole for 2000 years.

Income of energy being received by the earth from the sun, after allowing for that radiated and reflected back into space, was equivalent to the energy of combustion of 17 million million tons of coal a year, or 8000 times the heat of combustion of the world's annual production of coal and petroleum at present. Dr. Parker went on to say that the equivalent of all the energy resources—capital and income—being harnessed and used by man to meet his needs, was about 3200 million tons a year. This meant that the energy harnessed to assist man in raising his standard of living was equal, for the world, to about 1·5 tons of coal per person per year. In the U.S.A. it was more than 8 tons per person, and in Great Britain it was about 4 tons.

Technical Education and Skilled Manpower

A report on the subject of technical education and skilled manpower has been sent by the chairman of the Parliamentary and Scientific Committee to the Minister of Education, the Secretary of State for Scotland, and the Lord President of the Council. In its introduction the report refers to earlier publications of the committee on the training of men and women for posts of high responsibility. It is pointed out that the future scientific and technological development of our industries depends not only on the ability of those occupying posts of high responsibility, but also on the training and skill of the rank and file. The report, therefore, deals with the training of skilled workers and covers a field of inquiry beyond that previously considered. The first of the two factors involved is, it is stated, the need to provide adequate training for those entering industry, and, secondly, the training of those already employed. As the problem is urgent every possible facility must be utilised, without waiting until ideal training methods have been evolved. In its recommendations the report points out that as the skilled craftsman is an essential link in the chain between scientific discovery and industrial practice his technical education and training are of primary importance. For this reason more industrial firms must accept their responsibility of producing skilled craftsmen, and in this connection close co-operation and understanding between employers, employees and technical colleges is essential to produce best results. The Committee considers that the development of the part-time day release from industry to attend technical college courses should be more widely supported immediately, and that there is urgent need for an increased technical element in secondary education for the large proportion of youth which will enter industrial employment. Dealing with technical colleges it is pointed out that these establishments need more modern equipment in their workshops to give effective training, and that there should be an improvement in the salary and superannuation conditions of their staffs in order to attract the most suitable class of teacher for the specialised class of work. Many other recommendations are made in the report which will be found an interesting addition to the other publications on this important subject which have been prepared by the Committee.

Ministry of Works Staff Changes

It is announced that Major-General H. W. B. Hughes, C.B., D.S.O., O.B.E., the Ministry of Works regional director for the South West Region, is to retire on September 30th, and that he will be succeeded by Mr. E. Hughes Jones, at present regional director North Midlands. Major-General Hughes has been the Ministry of Works Regional Director for the South West Region since March, 1947. Previous to that he had been the Ministry's Regional Director for the North Midlands. During a distinguished military career he was Chief Engineer, IV Corps (1939–40), Engineer-in-Chief, Middle East Forces (1940–43), Engineer-in-Chief, Supreme Headquarters, Allied Expeditionary Force (1944) and Engineer-in-Chief of the Army and Director, Royal Engineers (1944–45).

Mr. Hughes Jones, who joined the Ministry of Works from the Assistance Board in 1945, was from July 1945, until his appointment as regional director for the North Midlands, secretary of the Building Apprenticeship and Training Council. He is to be succeeded in the North Midlands Region by Mr. W. T. Lewis, who has held the post of assistant regional director of the Ministry at Nottingham since March this year. Prior to this appointment, Mr. Lewis was at the London headquarters of the Ministry and he was the Secretary to the Working Party for the Building Industry, the report of which was published earlier this year.

Revision of Shipbuilding and Ship-Repairing Regulations

A revision of the existing regulations under the Factories Acts for shipbuilding and ship-repairing has been contemplated for some considerable time and the Ministry of Labour and National Service has now published a preliminary draft of revised regulations. A committee, upon the recommendations of which the Shipbuilding Regulations of 1931 were based, urged that its recommendations should be applied to the repair of ships afloat in public wet docks and harbours as well as in shipbuilding yards and public dry docks, and that the scope of the regulations should be extended accordingly when amending legislation had been passed. Such legislation was included in the Factories Act of 1937. Further, some difficulties have been raised in connection with the existing regulations (more especially as regards precautions against fire or explosion on oil-carrying vessels), and developments in methods and conditions of work have also to be taken into account.

Revision of the regulations has been delayed in view of circumstances arising out of the war; but the Ministry has now circulated copies of the preliminary draft to organisations concerned as a basis for consideration. These organisations have been invited to send to the Ministry statements indicating which points on the preliminary draft they would like to discuss with representatives of the Ministry. Following these discussions, it is intended to prepare a revised draft for formal publication under the statutory procedure.

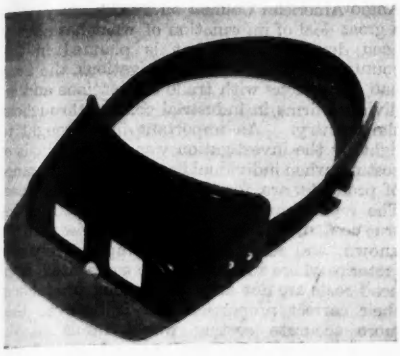
Death of Mr. E. S. Broadhead.—We regret to record the death, on August 19th, of Mr. Edward Sidney Broadhead, M.I.C.E., chief designer for J. L. Eve Construction Company, Ltd., Wimbledon, S.W.19. He was responsible for many interesting designs, including the Forth, Clyde, Cart and Tay River crossing towers for the Central Electricity Board, and the 350ft radar towers for the Air Ministry.

Materials and Fabrication.—We have received from T.I. Aluminium, Ltd., a copy of its new publication, "Introduction to Materials and Fabrication in Aluminium and its Alloys." The handbook briefly lists the company's alloys and explains the meaning of heat-treatment terms, while tables give details of related specifications, mechanical properties and chemical compositions. Other sections touch upon design, workshop practice, methods of joining and surface treatment.

A Magnifier and Eye Shade

A VERY useful combined binocular magnifier and eye shade is now being made by Brookes and Adams, Ltd., of Barr Street, Hockley, Birmingham, for the use of inspectors, tool makers, instrument makers and similar craftsmen engaged on fine work. This instrument, which is known under the trade name "Bandalasta," is illustrated below. It has been developed to replace the generally used single eye glass which, when supported in one eye for long periods to do fine work, read small vernier scales, &c., becomes uncomfortable and often causes eye strain.

The instrument is fitted with prism lenses of 8in focal length and ×2 magnification. The lenses are set in a well-proportioned moulded



BINOCULAR MAGNIFIER

eye shade of "Bakelite" material, and the design is such that it can, if necessary, be worn over spectacles. Ample ventilation space round the lower part of the shade keeps the wearer's eyes cool and obviates the misting of lenses by perspiration. The head band is riveted to the shade and its adjusting screw is also made in "Bakelite" material to provide a firm supporting member which is unaffected by temperature and does not rot or corrode.

The "Bandalasta" is very light, weighing only about 3¼ oz, and it can be worn for long periods without strain or discomfort.

Unplasticised Polyvinyl Chloride

THE physical and chemical properties of unplasticised polyvinyl chloride make it suitable for a wide range of applications in the chemical and allied industries. Since it was

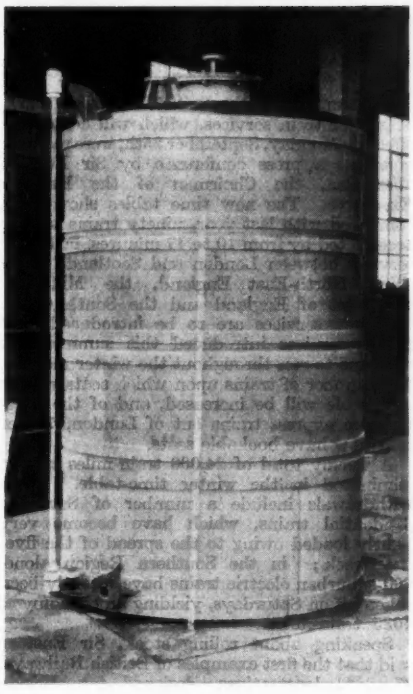
P.V.C. VALVE

introduced into this country by Tanks and Linings, Ltd., of Town Wharf, Droitwich, Worcs, some two years ago, for full-scale industrial application, the material has been used in various forms for many classes of work.

In one form, known as "Nutravic," non-plasticised or low-plasticised polyvinyl chloride is used for lining tanks, vats, &c., of wood or metal, and in another form, known as "Nutradur," as a constructional material in the manufacture of component parts for plants in the chemical, foodstuffs, brewery and other industries.

"Nutradur" is a thermoplastic which is highly resistant to a wide range of acid and other corrosive compounds, and it can be used in making parts handling heated liquids up to 40 deg. Cent. continuously, or 50 deg. Cent. for short periods, without losing its mechanical properties. At 15 deg. Cent. it has a tensile strength of 9000 lb per square inch, and a compressive strength of 10,000 lb. The makers do not recommend the use of the material at temperatures above 60 deg. Cent. as the mechanical properties deteriorate with increasing temperatures. As "Nutradur" is not affected by even very strong oxidants and light it does not age, and over long periods of use within the stipulated conditions no embrittlement has been known to take place.

The company has the material available in sheets 4ft 6in long by 2ft wide, in thickness from 0·02in to 2in; in rods from 0·8in to 1·5in diameter, and in tubes from 0·5in to 6in diameter. From this range of elements



TANK FOR ACIDS

components and units are built by using the normal machining processes and assembly by welding with a hot air torch.

The ease with which the material can be manipulated and fabricated has enabled its use in the manufacture of a variety of fume ducts, pipe-lines, &c. Typical of the components for which it has been adopted is a range of acid and alkali-proof valves made from "Nutradur," marketed by the company. These valves are made for use in lines from ¼in to 6in bore, those from 1in to 6in being of the plug type shown in one of our illustrations. Each valve consists of a number of pressed shapes welded together by means of a hot air torch and having the flanges rigidly supported by two bridges and reinforcing rods fused in position.

The largest tank made completely of the material by the firm is shown in our second illustration. It is of 400 gallons capacity and is used for 60–90 per cent concentration of sulphuric acid. Made of 0·394in thick material the tank is 4ft diameter, 6ft 6in high, and has a dished top and bottom. Two sets of 2in wide reinforcing rings are welded over the circumferential joints, and reinforcing webs are set across the concave bottom of the tank. The fittings within the tank are also made of unplasticised polyvinyl chloride and include a float-operated valve designed to maintain automatically the level of the liquid, which is fed by gravity from an acid-proof lined concrete storage tank some distance away. When being hydrostatically tested prior to being installed, the tank was filled with liquid and coupled to a 15ft high standpipe containing a sufficient level of liquid to impart a maximum internal pressure of 11 lb per square inch.

Refuse Disposal Experiments

THE Chemical Research Laboratory, D.S.I.R., in collaboration with local authorities, is carrying out some interesting experiments to help solve the problem of the disposal of refuse. The methods suggested will, if successful, also help to reclaim derelict land for useful purposes.

The disposal of refuse is an important and awkward problem. Incineration is expensive and even after incineration about 40 per cent of the total volume of rubbish remains for disposal. There is also a serious shortage of tipping sites. On the other hand, many areas of the country are studded with large gravel pits and quarries, now worked out, and most of them filled with water. If the rubbish could be dumped into these pits, not only would a new and cheap method of refuse disposal be available, but considerable areas of derelict land, which could be used for housing or agriculture, would be reclaimed. The disadvantage of this method, as some authorities know to their cost, is that indiscriminate tipping may easily cause a serious nuisance. In some exceptional cases this has not happened, but the risk is always there.

The nuisance is caused by the growth of living organisms known as sulphate-reducing bacteria. These bacteria transform sulphates in contaminated waters to hydrogen sulphide. Sulphate-reducing bacteria exist in almost all soils and waters, but do not begin to grow until suitable organic matter is fed to them. When rubbish containing putrescent material is tipped into a wet pit the sulphate reducers may grow very rapidly and produce large quantities of this foul-smelling gas. Pits contaminated in this way are a nuisance to people living near them. Cases have been reported to the Chemical Research Laboratory in which the paint of nearby houses has been blackened both inside and out and it has been impossible to keep silver and copper utensils clean and bright.

The experiments in progress now are being carried out by the C.R.L. in collaboration with the Twickenham Borough Corporation. A new refuse disposal works is being built in the centre of a ring of wet gravel pits, and it would obviously be desirable if the clinker from the incinerators and the fine refuse which is not incinerated could be tipped into them.

Both the materials have been tested in the laboratory. The clinker produced no sulphuretted hydrogen even after long incubation in water, but with the fine refuse it began to evolve after only twenty-four hours. The Borough Engineer in charge of the scheme has suggested dividing one of the pits, containing about 120 million gallons of water, into lagoons holding about 1 million gallons, the walls of the lagoons being made of the inert clinker. The idea is that the fine putrescent refuse should be tipped so quickly into the comparatively small lagoons that they would be completely filled before any nuisance developed. If any sulphuretted hydrogen should occur it could easily be stopped by adding sufficient acid to prevent further growth of the bacteria.

An experimental lagoon has been built to test the method on a practical scale. Tipping of the fine refuse has begun and early results are encouraging. It would be even better to be able to tip crude household refuse direct into the lagoons without the trouble and expense of incineration, and it is proposed to try this practice after the experiments with the fine refuse have been completed.

The ideal solution to the problem would be

to use another micro-organism which consumes the sulphuretted hydrogen as fast as the sulphate reducing bacteria produce it. There are several types of bacteria which consume sulphuretted hydrogen, and the possibilities of this method of control are being investigated.

English Electric Company Appointments

It has been announced by the English Electric Company, Ltd., that owing to the company's increasing business in overseas territories, Mr. Leonard H. Short, M.C., M.I.E.E., has been appointed deputy general export manager. For some time Mr. Short has, in addition to being responsible for certain specific export fields in the company's overseas activities, been chief of administration of its traction department. Administration of the traction department is to be taken over by Mr. C. M. Cock, M.I.Mech.E., M.I.E.E., until recently chief electrical engineer of the Railway Executive.

Mr. Cock has had a distinguished and active career in the railway and engineering world, both abroad and in this country. Born in Melbourne, Australia, he was educated and received his technical training and early experience in Australia at the Melbourne Technical School and with the Victorian Railways. During the first World War he served in the Royal Navy, and in 1919 he joined the construction staff of Merz and McLellan, consulting engineers, in Melbourne. With that firm Mr. Cock worked in connection with the electrification of the Melbourne Suburban Railways, and a large power project for the Victorian Electricity Commission. He later transferred to India as one of the supervising engineers working on important railway electrifications. In 1929 he joined the G.I.P. Railway Transportation (Operating) Department and held appointments as distribution engineer and rolling stock engineer before being appointed Traction Superintendent and later Divisional Superintendent for the Area, including Bombay. Between June, 1941, and February, 1942, Mr. Cock was loaned to the Royal Indian Navy, and in 1942 was recalled to his post as Divisional Superintendent, G.I.P. Railway. In 1945, Mr. Cock returned to England to take up the post of Chief Electrical Engineer to the Southern Railway, and on the nationalisation of the railways in 1948 he was appointed Chief Electrical Engineer to the Railway Executive.

The two new appointments will take effect as from October 1st next.

Rolling Mill Equipment for Norway

Particulars of an order for rolling mill equipment for Norway were announced last week by Davy and United Engineering, Ltd., Sheffield. The contract, which is valued at more than £1,000,000, is concerned with plant required for a new integrated iron and steel works to be operated by A/S Norsk Jernverk, in Northern Norway, at Mo i Rana, 25 miles south of the Arctic Circle. The plant ordered includes a 42in by 9ft high-lift reversing blooming and slabbing mill, together with a 32in two-high, reversing, three-stand, structural mill for producing sections up to 16in or 18in beams. The plant will be complete with a 900 tons electric bloom shear, a 350-ton electric billet shear, fixed and travelling electric sliding-frame hot saws, cooling banks and much other auxiliary equipment, and will comprise in all nearly 7000 tons of finished machinery. When in operation it will extend in length over more than 1100ft of ground. The plant will be capable of handling bloom ingots up to 3½ tons in weight and 5-ton slab ingots, and, it is claimed, will have an initial output of up to 220,000 ingot tons per year. In addition, the blooming mill is being designed for a total capacity of 650,000 tons per year against future expansion plans for the works.

Ingot lifting and weighing equipment positioned in the approach table roller gear precede the blooming mill, which is of the high-lift type with a lift of 58in. It will be powered by a twin motor drive, will have electric universal manipulators, twin motor screwdown, hydraulic balance on top roll and both spindles, and housings weighing approximately 70 tons each. The electric bloom shear, it is stated, will cut up to 12in by 12in blooms or, alternatively, 36in by 5in slabs; it will be followed by a bloom transfer for sale blooms and light slabs. Provision is made in the approach table to the first stand of the structural mill for transfer to a wash heat furnace for reheating where necessary on certain small products. This will be effected by an electrically driven bloom charger mounted on its own roller table which can be traversed the full extent of the wash heat furnace. The three-stand structural mill will be driven from one end through pinion housing and spindles by a single electric motor drive. The first stand of this mill is a 32in mill, the second and third stands being 30in mills. Billets up to 6in square coming from the second stand can be sheared by a 350-ton electric billet shear and then either kicked off into cradles or carried over a cooling bank for eventual sale. Material smaller than 6in by 6in will be transferred into the third stand, run straight out and sawn to length, and then passed to a cooling bank.

The new plant will assist a considerable increase in Norwegian steel production. It is expected that it will go into production in 1954.

The Winter Train Services

Particulars of the British Railways' 1950–51 winter train services, which will come into effect on Monday, September 25th, were recently given at a press conference by Sir Eustace Missenden, the Chairman of the Railway Executive. The new time tables show that, compared with last year, ninety trains will be accelerated by from 10 to 47 minutes, including services between London and Scotland, Yorkshire, North-East England, the Midlands, the West of England and the South Coast. Nine new services are to be introduced, and fifteen services introduced this summer will continue to run throughout the winter months. The number of trains upon which seats will be reservable will be increased, and of the long-distance express trains out of London, 75 per cent now have bookable seats.

A weekly total of 24,000 train-miles will be eliminated in the winter time-table. These withdrawals include a number of Saturday residential trains, which have become very lightly loaded owing to the spread of the five-day week; in the Southern Region alone, 100 suburban electric trains have recently been taken off on Saturdays, yielding an economy of 1085 train-miles.

Speaking about rolling stock, Sir Eustace said that the first examples of British Railways' standard locomotives, designed for a wide range of use and enabling a greater number of older types to be replaced, will be introduced in 1951. It is hoped to announce advance details shortly.

Designs for standard all-steel carriages are well advanced and twelve types are to be built during 1951, including kitchen cars and passenger brake vans; these will incorporate a wide range of components, which will be standard throughout the whole series. A prototype coach, illustrating alternative treatment of carriage interiors, will be available later this year.

So far, about 1180 miles of track have been partially or completely renewed this year; about half the complete renewals have been with the new standard flat-bottom rails. By the end of 1950 it is anticipated that a further 690 miles of track will have been completely or partially renewed, making 1870 miles in all during 1950. By that time there will be approximately 1570 miles of track on British Railways with the new flat-bottom rail.

Relaying is being speeded up by the use of an increasing number of mechanical devices and, in tunnels and other confined spaces particularly, mechanical track-laying units are now doing work which formerly had to be done by hand under great difficulties.

Simplification in British Industry

A year ago a team appointed by the Anglo-American Council on Productivity made an investigation of simplification in industry in the U.S.A. The team was led by Major-General J. S. Crawford, C.B., a vice-president of the Society of Motor Manufacturers and Traders, Ltd., and in its report recorded the opinion that an organised and determined effort to reduce manufacturing variety still further in this country could result in increased productivity and lowered costs in British industry.

The same team has now made an inquiry into the progress of simplification in the industries of the United Kingdom, and its report on the matter, which was published last week by the Anglo-American Council on Productivity, gives a great deal of information of what has already been done and of what is planned in this country. To assist its investigations, the team had discussions with trade associations and individual firms in industrial centres throughout the country. An important fact brought to light by the investigation was that methods of costing, when individual firms have a wide range of products, are, for the most part, inaccurate. The report says that, generally speaking, the true costs of small-run and special orders are not known, and except in the comparatively few factories where such orders are segregated, overhead costs are not allocated among products in their correct proportions. It is believed that more accurate costing would result in the elimination of much needless and unprofitable variety.

Another matter mentioned in the report is the prevailing misconception about the effects of simplification on the consumer. The team thinks there is no reason why simplification should result in lower quality standards or inadequate choice, and says that greater concentration by a producer on a narrower range of types does not by itself imply less total variety. Each producer, the report states, is still free to make his own selection of products and the existence of consumer demand for any particular article will ensure its supply. The necessity for organising surveys of the possibilities of simplification is stressed, a task, it is suggested, which might be undertaken by the appropriate trade associations. The report also emphasises the part played by the designer in simplification, and the requirements of the export market. Finally, there is presented in the report a brief account of practical experience of simplification in a wide range of industries, including the iron and steel industry and several branches of the engineering industry. Here there are given some striking examples of reduction in types of product and the consequent effect on costs and prices.

A.E.C., Ltd., Southall Works, Middlesex, announces that following the retirement of Mr. G. J. Rackham, Mr. G. D. Robinson, M.I.Mech.E., has been appointed chief engineer of the works. Mr. R. A. Fryars, who succeeds Mr. Robinson as chief designer, has been the experimental engineer to the company since January, 1948.

Discussion on Heat Transfer.—At a conference, to be held in London on September 11 to 13, 1951, the Institution of Mechanical Engineers, with the active co-operation of other kindred societies in Britain, the British Commonwealth and Europe, is arranging for the presentation of groups of papers on many aspects the advance of knowledge in the mechanism of the transference of heat and the design of apparatus for making use of such knowledge. Working jointly with the Institution is the American Society of Mechanical Engineers, which, with the assistance of other societies in the Western hemisphere, is organising the preparation of papers by American authors for presentation in London. The subject-matter of the papers, it is proposed, should be restricted to the developments which have taken place during the years 1940 to 1950 and the following main headings have been agreed: heat transfer with change of state; heat transfer between fluids and surfaces; conduction in solids and fluids; radiation, instrumentation, measurement techniques and analogies; special problems such as heat transfer in turbine-blade cooling, in liquid metals, in gas turbines and in piston engines; the mercury boiler, &c.

Industrial and Labour Notes

Confederation of Shipbuilding and Engineering Unions

AMONG the resolutions discussed at the recent annual conference of the Confederation of Shipbuilding and Engineering Unions, was one calling for the termination of the procedure for the avoidance of disputes in the engineering industry. This resolution, submitted by the Amalgamated Engineering Union, said that as the employers appeared to be adamant in their refusal to amend the procedure, "this annual conference instructs the Executive Council to give the necessary notice to terminate the agreement for the avoidance of disputes with a view to initiating discussions for the enforcement of our demands."

It may be recalled that a year or so ago the Confederation submitted some proposals to the Employers' Federation which suggested the establishment of a central council, with equal representation from both sides of the industry. Some of the functions of the council, it was proposed, should be to secure the largest possible measure of joint action between employers and workpeople for the development of the engineering industry as a part of national life and for the improvement of the conditions of all engaged in that industry; the regular consideration of wages, hours and working conditions in the industry as a whole; the consideration of measures for regularising production and employment; and the consideration of the existing machinery for the settlement of differences between different parties and sections in the industry, and the establishment of machinery for this purpose, where it does not already exist, with the object of securing the speedy settlement of difficulties. The Employers' Federation intimated that it could not see its way to agree to the proposals made by the unions, its view being that to attempt to replace or superimpose other arrangements on the well-tried and effective provisions for avoiding disputes and other agreements and understandings between the Federation and the unions was not in the best interests of the industry. Following that reply there was no further action on the matter by the Executive Council of the Confederation owing to its "overriding preoccupation" with the wages problem.

Resolutions on wages questions which were passed by the annual conference included one calling for a conclusion of the negotiations on a new wage structure for the engineering industry and directing the Executive Council to fix a date for the termination of such negotiations. If a satisfactory conclusion should not have been reached by then, the resolution urged that the matter should be referred to a Government Court of Inquiry.

The Trades Union Congress

The eighty-second annual Trades Union Congress opened at Brighton on Monday last, September 4th, under the presidency of Mr. H. L. Bullock. The report of the General Council, which was presented at the Congress, is, as usual, a lengthy document, which summarises T.U.C. activities during the past twelve months. It records, of course, the consideration which has been given during the year to the policy of wage restraint, and sets out the reasons which led the General Council to amend its wages policy at the end of June. In a statement then issued to affiliated unions, the General Council said that it recognised the need for greater flexibility in the matter of wages, but urged, at the same time, that this should not be taken as justifying a competitive scramble for increases.

On Wednesday of last week the General Council decided to issue a supplementary report dealing with the present international situation. In a declaration on this matter, which has been put to the Congress, it is stated that the acceptance by this country of its obligations under the United Nations Charter will bring further burdens upon the British people and that "there will inevitably be some diversion of the country's limited resources from the task of rebuilding the national economy on which such encouraging progress has been made."

The General Council also gave approval last week to recommendations by its Production Committee on problems of industrial production. This Committee's conclusions, it is stated, have been reinforced by the report of the team of trade unionists which recently visited the U.S.A. It has now been decided that affiliated unions shall be encouraged to interest themselves in the employment of modern production and management techniques designed to improve industrial efficiency, and unions and union federations are to be asked to consider the employment of staff qualified to advise and assist on production problems, and the establishment, in appropriate cases, of their own production departments. Unions are to be invited, too, to provide generous educational and training facilities for their members.

The National Coal Board

At the end of last week the National Coal Board issued a statistical statement on the costs of production, proceeds and profits of collieries for the first quarter of this year. It shows that total production costs during that quarter amounted to £116,880,100 and total proceeds from the sale of coal to £126,833,111, leaving a profit, before charging interest, of £9,953,011. The estimated profit from ancillaries was £660,000, making the Board's gross profit £10,613,011. After making provision for compensation for loss of office, interest payable to the Minister of Fuel and Power, and liability for profits tax, the surplus at the end of the first quarter was £5,600,011.

Dealing with coal output, the statement indicates that in the first quarter there were 48,450,960 tons for disposal commercially. Mine consumption accounted for a further 2,726,783 tons and miners' coal for 1,401,881 tons. Of the total production costs, the sum of £76,244,559 was needed for wages, £14,709,742 for roof supports, general stores and repairs, £6,684,671 for coal and power consumed, and £16,541,128 for other costs, including depreciation. Average earnings of all workers during the period reviewed were £8 10s. in cash and 8s. 6d. in kind per week. Underground workers, it is estimated, earned on an average £9 11s. 5d. per week, to which is added 8s. 8d. as the value of allowances in kind.

It may be added that in the week ended August 26th coal production began to show some recovery from the effect of the holidays, output from the deep mines being 3,846,500 tons and opencast workings 220,500 tons, making a total of 4,067,000 tons, compared with 3,958,400 tons in the preceding week. In the first thirty-three weeks of this year total coal output in Great Britain was 135,424,200 tons, against 133,798,700 tons in the corresponding period of 1949. Mining manpower, however, continues to decline, the latest report showing 695,400 on colliery books, compared with 719,400 a year ago.

Non-Ferrous Metals

Following a reduction last week in the price of copper, the Ministry of Supply has now announced an increase. From September 1st the price of electrolytic copper has been raised by £16 a ton to £202, delivered consumers' works.

Early last week the Ministry of Supply stated that, as ample stocks of copper, lead and zinc will be available to meet consumers' current requirements as they arise, abnormal purchases by consumers, whether for immediate or deferred delivery, are unnecessary and undesirable. To discourage excessive forward buying during the present volatile state of the markets, the Ministry has decided that, from August 26th, additional charges for forward purchases shall be as follows:—Copper, £13 10s. for second and third months after month of order and £15 for fourth, fifth and six months after month of order; lead, £7 for second and third, and £8 for fourth, fifth and six months after month of order; and zinc, £13 for second and third months, and £14 for fourth, fifth and sixth months after month of order.

Steel Consumption by Industry

The British Iron and Steel Federation has just published, in its *Monthly Statistical Bulletin*, an analysis of steel consumption by industry. It points out that before any attempt can be made to forecast the demand for steel at some future date, the pattern of consumption in a given base period must be known. For that reason it has been decided that the collection of distribution statistics shall be continued, even though—except for sheets and tinplate—the rationing of supplies is no longer necessary. Under arrangements which came into force on June 4th, a purchaser of steel in this country is required to quote to his supplier a symbol corresponding to the industry grouping in which his main activity falls, and steel producers make returns of their deliveries against each of those twenty-six symbols as well as of their deliveries for export and to stockholding merchants. When the scheme is working smoothly it will obviously provide valuable information on the flow of steel to consuming industries in greater detail and in more useful form than statistics hitherto collected.

Meanwhile the British steel industry's forward planning continues, and the industry is now engaged in drawing up a new development plan which will provide the efficient capacity required to meet the estimated demand for the principal steel products in 1960. As an essential preliminary to the detailed assessment of requirements, estimates have had to be made of the pattern of consumption during 1949. The results for the year as a whole indicate that finished steel deliveries industry by industry were as follows:—Shipbuilding and marine engineering, 9 per cent; building and constructional engineering, 13·1 per cent; mechanical engineering, 22·8 per cent; electrical engineering, 5·5 per cent; motors, cycles and aircraft, 10·2 per cent; railways and rolling stock, 8·3 per cent; collieries, 5·4 per cent; hardware, hollowware, etc., 9·5 per cent; rivets, bolts, nuts and springs, etc., 4·9 per cent; wire and wire manufactures, 6·7 per cent; miscellaneous, 4·6 per cent. One of the points brought out by the Federation's analysis is the paramount importance of the mechanical engineering industry as a steel consumer, for the investigation revealed that mechanical engineering, the building group and the motor industry group were together responsible for almost half of last year's finished steel deliveries. Another point is that steel consumption in this country last year was 58 per cent greater than in 1935. The mechanical engineering industry, however, took two and two-thirds times its 1935 requirement and electrical engineering more than three times as much.

But the Federation emphasises in its survey that the demand for steel will depend, not only upon the activity of the economy as a whole, but also upon the changing pattern of industrial production. To the question of what changes are likely to occur during the next decade, considerable thought is now being given.

Sweden's Iron and Steel Industry

According to *The Anglo-Swedish Review*, plans are in hand which provide for the investment of 391,000,000 kroner to expand and modernise the Swedish iron and steel industry over the next two years. The intention is to eliminate manual operations as far as possible in order to increase efficiency. It is stated, however, that the industry will require an additional 2900 workers by the end of this year. Evidently many Swedish enterprises, especially ironworks and manufacturing industries, are complaining of a labour shortage at present. It has been estimated that the number of employees who left their occupations in the first four months of this year was as great as the number leaving during the first six months of last year.

British Patent Specifications

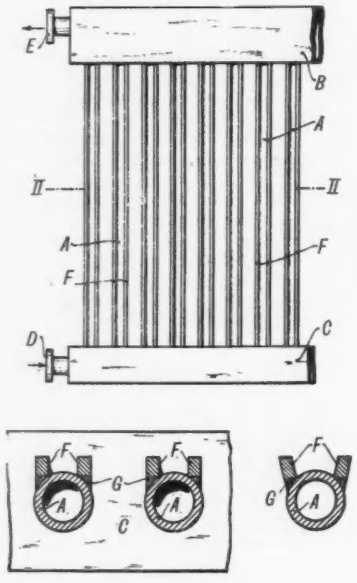
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

STEAM GENERATORS

639,881. December 2, 1947.—Improvements in and Relating to Water-Cooled Grates, Huygen and Wessel C.V., of Amersfoort, the Netherlands.

The invention relates to a water-cooled grate for a furnace consisting of hollow grate bars, through which cooling water flows. The accompanying drawings show a plan view of the grate, a cross-sectional view on enlarged scale of part of the grate along the line II—II, and a view of a grate bar of modified form. The grate bars *A* at one of their extremities are connected to a header *B* which forms the dead plate, and at their other extremities the bars are connected to a header *C* serving as fire bridge. The cooling water enters into the header *C* at *D* and flows through the hollow bars *A* in order to leave the header *B* at *E*. To each bar two longitudinally extending metal strips *F* are welded at *G* so as to form ribs. In the groove

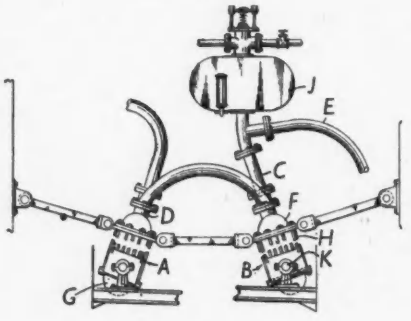


No. 639,881

formed between the ribs, dust and fine particles of ash accumulate, whereby the layer of fuel is protected against cooling. As shown, the ribs *F* need not be vertical and parallel, but may instead be arranged at an inclination one with respect to the other. As the ribs are welded to the tubular bars along their whole length a favourable transfer of heat at the joint is secured, so that the ribs are not burnt. The grate, when used in a steam boiler, may be connected to the water circulation system of the boiler, and the invention may be applied to horizontal grates as well as to inclined grates.—*July* 5, 1950.

640,271. July 8, 1947.—Improvements in Boiler Feed Water Heaters, Panaghis Petrou Vergottis, of 364, Hamilton Avenue, Norfolk, Virginia, U.S.A.

This invention relates to improvements in boiler feed water heaters or economisers, particularly useful in marine boilers as well as various other kinds. The primary object of this invention is to provide improved support for a single or multiple unit feed water heater giving compensation for normal expansion and contraction of the tubes and other parts of the feed water heater and associated boiler structure in operation. The drawing shows feed heater units *A* and *B* each having an inlet conduit *C* and *D*. A pipe *E* is secured to a suitable by-pass valve (not shown) and, to the inlet conduit *C*. The pipe *E* extends from the usual water feed pump of the boiler. Each unit has an upper header *F* and a lower header *G*, connected by stay rods *H*, held in position by nuts. A number of small diameter, thin-walled tubes extend between the tube plates of the upper and lower headers and baffles are provided. The inlet conduit *C* is connected to an air vessel *J*, above the heater units. The vessel has a water



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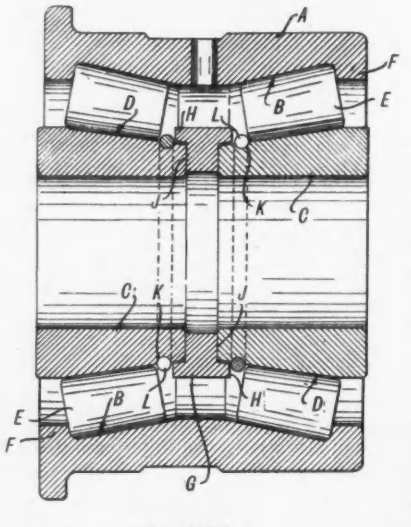
gauge. The heaters are mounted within the flue or smoke-box of the boiler, by means of end plates secured to the lower tube plates and carrying trunnions or stub shafts *K*, extending horizontally therefrom. The units are also flexibly supported at their upper ends to permit movement resulting from expansion and contraction of the tubes or other parts.—*July* 19, 1950.

MISCELLANEOUS

640,329. March 11, 1948.—Improvements in or relating to Double-Row Roller Bearings, The Timken Roller Bearing Company, of 1835, Dueber Avenue, S.W., Canton, Ohio, U.S.A. (assignees of Albert Leontinus Bergstrom).

This invention relates to roller bearings of the type comprising two axially spaced circular series of rollers, a single outer bearing member for both series of rollers and a separate inner bearing member for the rollers of each series. It has for its principal object to provide a bearing that can be quickly and easily assembled to form a self-contained unit, while other objects are simplicity and cheapness of construction and compactness of design. In the accompanying drawing the bearing comprises a single outer bearing member or cup *A* having two conical raceways *B* therein that taper towards the middle of the bearing, two separate cones or inner bearing members *C* having conical raceways *D* which taper towards each other, and a circular series of conical rollers *E* interposed between the raceway of each inner bearing member and the



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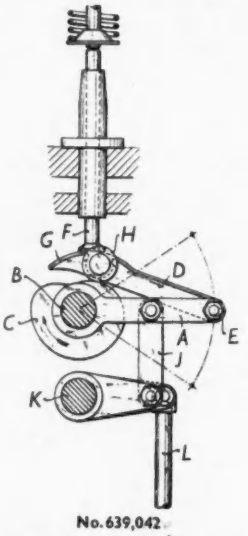
corresponding raceway of the outer bearing member. The outer bearing member *A* has internal peripheral thrust ribs *F* that are integral therewith and overlap the large ends of the rollers *E*. Interposed between the inner bearing members *C* is an annular spacer member *G* of sufficient thickness to give the inner bearing members the position required for proper running clearance between the rollers and the raceways. The annular spacer has a wide outer peripheral end flange *H*, forming in opposite ends of the spacer annular recesses *J* adapted to receive the adjacent inner end portions of the inner bearing members *C*. Each of the inner bearing members has an external annular groove *K*, and seated in said groove is a split snap-on retaining ring *L* that forms on the inner bearing member an external peripheral rib that overlaps the inner ends of the rollers. By this arrangement the body of the annular spacer *G* serves to give the inner bearing members or cones the position required for proper running clearance between the rollers and their raceways, while the thrust ribs *F* at the outer ends of the single outer bearing member or cup and the retaining rings *L* on the inner end portions of the inner bearing members or cones serve to prevent axial separation of the bearing parts in either direction, thereby permitting the entire bearing assembly to be handled as a complete self-contained unit. The simple assembly of this bearing is also described.—*July* 19, 1950.

639,042. October 19, 1945.—Improvements in and relating to Valve Gears for Engines, Wilhelmus Aloysius Hattink, of 25, Canisiusingel, Nijmegen, Holland.

According to this invention, an adjustable rocking element is provided with a convexly curved working surface directly engaging the driven element of the gear so that the driven element has its initial position displaced upon adjustment of the rocking element. With this arrangement the admission, or exhaust, may be varied in wide limits and even zero admission may be obtained without introducing clearance in the gear or varying the initial clearance. In the accompanying drawing the adjustable lever *A* is rotatably mounted on the shaft *B* bearing the cam disc *C*. The rocking lever *D* oscillates about a pivot *E* on the adjustable lever *A* and acts on the pushrod *F* by means of its working face *G*, which is convexly curved, the rod transmitting the movement to a driven element such as



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a valve stem loaded by a spring. The rocking lever *D* carries a roller *H*, which by the pressure of the valve spring continually bears against the circumference of the cam disc *C*. To the adjustable lever *A* is connected a rod *J* coupled to the adjusting shaft *K*, which receives its motion from rod *L*. To this end the rod is connected to a governor or to a servo-motor, so that two or more valves arranged to work next to each other but in different phases, due to the angle enclosed by adjacent cranks of a multi-cylinder engine, may be controlled by a common governor or servo-motor.—*June* 21, 1950.

Kuwait Oil Production Developments.—Kuwait, which lies at the head of the Persian Gulf and has an area of approximately 6000 square miles, has experienced, during the last few years, a tremendous expansion in oil production from under 1,000,000 tons per year to approaching 15,000,000 tons. The rapid change brought about by the speedy expansion of the oil industry has caused an economic somersault in a country which was previously a rather poor agricultural community. The discovery of the Burgan field has proved to be of major importance, oil being produced in ever-increasing quantities from depths lying between 3500ft and 4800ft, and deeper test drills are being made and other areas explored. Oil from the gathering centres is pumped through 20in pipe-lines to the tank farm at Ahmadi, lying at an elevation of 400ft above sea level from where it flows by gravity to the coast near Fahahil. At this point a new loading pier with a T-head and sufficient depth of water to berth the largest tankers, is now in operation. The handling capacity is 3000 tons an hour and six tankers can be loaded simultaneously.